ARCTIC DATA COMPILATION AND APPRAISAL VOLUME 22
Northwest Passage: Chemical Oceanography - Hydrocarbons, Metals, Pigments, Nutrients, Oxygen and Others 1979 through 1990 SUPPLEMENT TO VOLUME 4 - UPDATE TO 1990

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SUPPLEMENT TO VOLUME 4 - UPDATE TO 1990

by

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PREFACE

These catalogues are produced by the Data Assessment Division at the Institute of Ocean Sciences. Joint government and industry contract projects have catalogued marine data sets with their focus being primarily upon oceanography and fisheries. Data set quality appraisals are included to assist in establishing the usefulness of certain data for particular kinds of analyses and the confidence to be placed in interpretations. These appraisals will assist in setting priorities for incorporating the most useful data in the national Marine Environmental Data Service (MEDS) archives. Additional uses include research planning (especially for climatological studies), and the provision of the best available resume of marine data sources for environmental assessments.

The continuing interest in Arctic offshore development activity has emphasized the need to review the sufficiency and suitability of available scientific information for design, regulatory and planning purposes. This review has been divided into three phases: (1) compilation and appraisal of all existing data sets; (2) analysis of the suitability of the historical data for contributing to questions of particular interest; and (3) analysis and interpretation of data and estimation of the scientific confidence in answering particular questions. This report on the chemical oceanographic data of the channels of the Northwest Passage is a contribution to the first phase.

Brian Smiley
Scientific Editor
Arctic Data Compilation
and Appraisal Series

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ABSTRACT

D.J. Thomas, F. Noone, A. Blyth and B.D. Smiley. 1991. Arctic Data Compilation and Appraisal. Volume 22. Northwest Passage: Chemical Oceanography - Hydrocarbons, Metals, Pigments, Nutrients, Oxygen and Others. 1979 through 1990. Supplement to Volume 4. Update to 1990. Can. Data Rep. Hydrogr. Ocean Sci. 5: (Volume 22, 86 pp.)

This volume is one of a group of catalogues designed to compile and appraise marine data sets for the Canadian Arctic. For ease of reference, the group has been organized with its subject matter divided into three disciplines: physics, chemistry and biology. The Arctic has been arbitrarily divided into seven geographical areas to include, where possible, major oceanographic regions. The format has been structured to facilitate comparison between subjects and regions. With such a large undertaking it is not possible to provide all reports at once. Therefore catalogues which are presently available in the series are indicated on the inside back cover of each volume.

Data collection is a continuing process and further updates of the catalogues are planned. Readers are invited to submit corrections and additions by writing the issuing establishment. These corrections will be incorporated in on-line computerized data set listings; they will be continuously available upon request.

SOMMAIRE

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Le présent volume fait partie d'un groupe de catalogues destinés à compiler et à évaluer les séries de données marines sur l'Arctique canadien. Pour plus de commodité, la question traitée est structurée en trois grandes disciplines: physique, chimie et biologie. L'Arctique a été divisé arbitrairement en sept régions géographiques qui englobent autant que possible les grandes régions océanographiques. Les catalogues sont présentés de façon à faciliter la comparaison entre les sujets et les régions. Le domaine est si vaste qu'il est impossible de fournir tous les catalogues en une seule fois. Les catalogues de la série actuellement disponibles sont indiqués à la fin de chaque volume à l'intérieur de la couverture.

La collecte des données est un processus permanent et il est prévu de mettre à jour les catalogues par la suite. Les lecteurs sont invités à soumettre par écrit les corrections et les additions à l'établissement auteur. Ces corrections seront traitées en direct sur ordinateur et incorporées aux listes qui pourront être obtenus sur demande.

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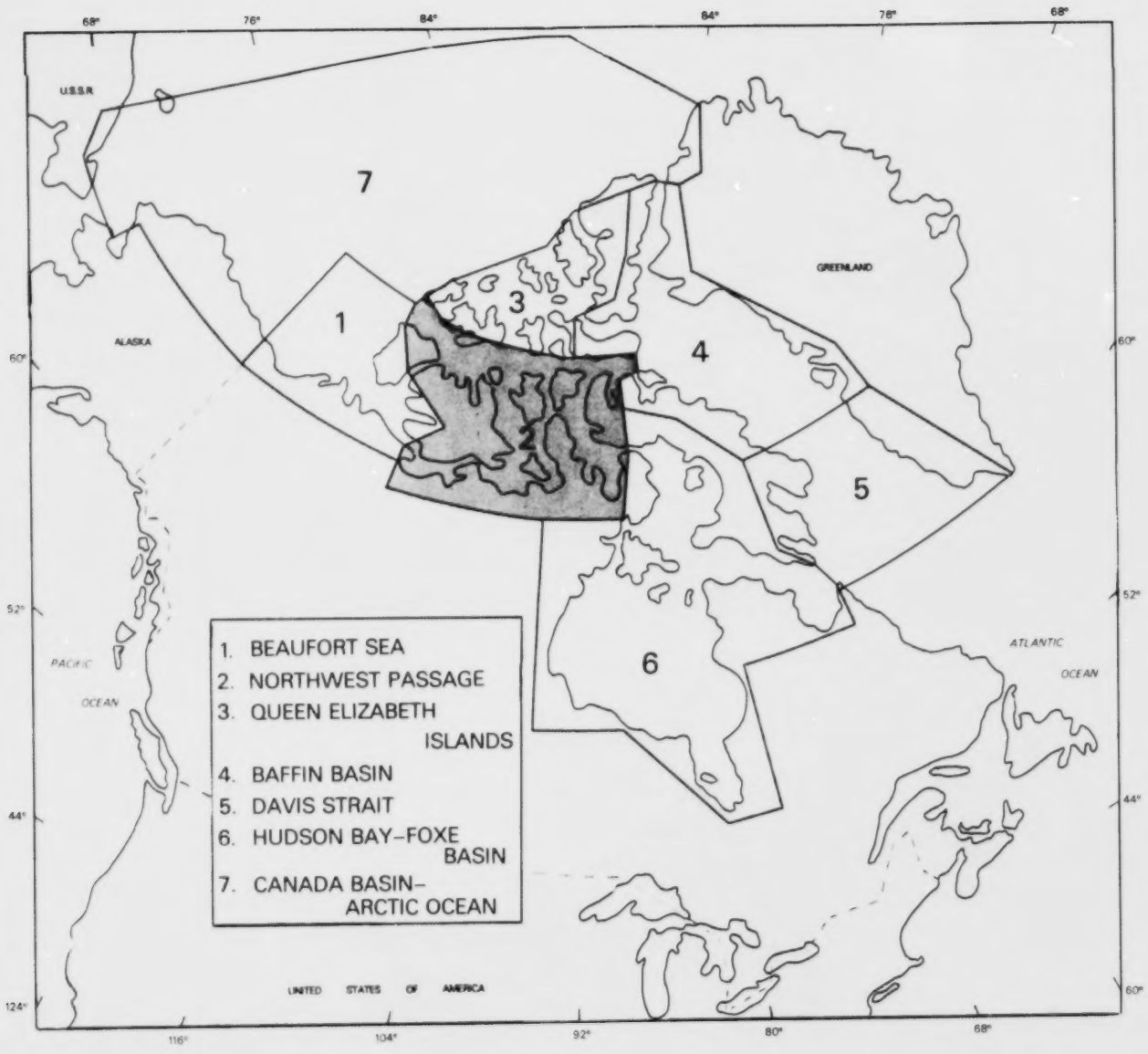
ARCTIC DATA COMPILATION AND APPRAISAL

VOLUME 22

NORTHWEST PASSAGE: CHEMICAL OCEANOGRAPHY
1979 through 1990

(Supplement to Volume 4. Update to 1990)



The area (2) covered by this volume is shaded on the map above.

Volume 22: Northwest Passage: Chemical Oceanography

VOLUME ABSTRACT

This inventory contains a catalogue of chemical oceanographic data sets from the Northwest Passage. It supplements the data published earlier as Volume 4 of this series. The inventory includes commonly measured substances such as major and minor elemental components and nutrients. Data sets are included for sea water, sediments and biota. Times and locations of measurements are listed and displayed graphically on a yearly and cumulative bi-monthly basis. A geographic index and alphabetical references (with data set number) are also included.

Key Words: Northwest Passage, chemical oceanography, data sets, inventory, pigments, nutrients, heavy metals, sea water, sediments, biota.

1. INTRODUCTION

This inventory comprises 9 data sets of chemical oceanographic data collected in the marine channels of the Northwest Passage during the period 1979 - 1990. These data sets supplement the 75 data sets provided previously in Volume 4. The quantity and type of data are distributed irregularly over time with the bulk of the data collection occurring after 1970 as shown in Figure 1.1.

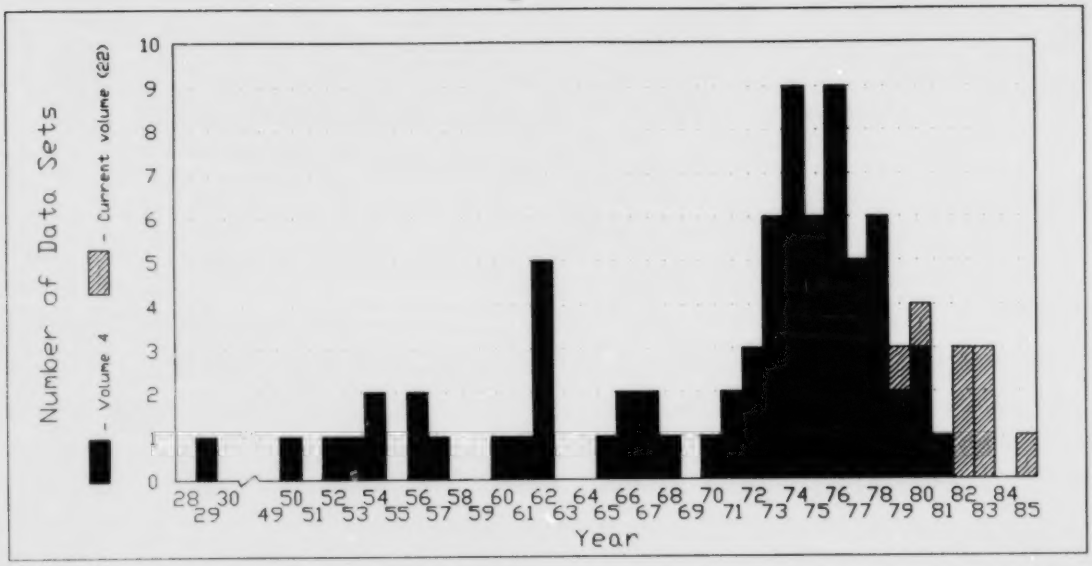


Figure 1.1 Yearly distribution of chemical oceanographic data sets for the Northwest Passage. The solid pattern indicates data sets from Volume 4 and the hatched pattern indicates data sets from this volume (does not include unverified data sets from the Freshwater Institute).

Most of the data reported in this inventory can be classified as baseline data and are statements of observed distributional patterns of the various chemical species. Before 1970, water column measurements such as dissolved oxygen and nutrients were virtually the only data obtained. After 1970, a wider range of data were obtained in response to a need for environmental data by government and industry interested in exploiting regional resources but usually on a very narrow geographical basis only, for example: (1) most of the data for heavy metals in sea water, sediments and biota apply to Strathcona Sound where extensive sampling programs were concerned with potential effects of a lead-zinc mining operation at Nanisivik and (2) most of the hydrocarbon data were collected in the Lancaster Sound area in anticipation of petroleum hydrocarbon resource development. The frequency of occurrence of selected chemical quantities is summarized for each sampling medium (sea water, ice, sediment and biota) in Table 1.1.

There is no evidence in the published literature for any systematic interpretation of the chemical oceanographic data to explain the observed distribution patterns in terms of fundamental oceanographic processes. The main reason for this is the limited data available.

The objectives of this inventory were (i) to provide an update to Volume 4 of all available Northwest Passage chemical oceanographic data sets collected up to 1990; and (ii) to appraise the quality of the data to obtain a broader perspective on what is currently known about the chemical oceanography of the marine channels of the Northwest Passage. The requests for data set information were sent to potential data sources in July 1990.

TABLE 1.1

FREQUENCY OF OCCURRENCE OF SELECTED CHEMICAL QUANTITIES FOR EACH SAMPLING MEDIUM

The numbers without parentheses are totals from both inventories (Volumes 4 and 22) and the numbers in parentheses are from this update only.

	Sea Water	Sediments	Biota	Ice Cores
Hydrocarbons				
Hexane/Benzane extractable compounds	5	-	-	-
Methane	1	-	-	-
Oil	1	1	-	-
Pesticides	-	-	4	-
Polychlorinated biphenyl	-	-	4	-
Tar	6	-	-	-
Metals				
Arsenic	1	5	7	-
Cadmium	4(1)	8(1)	8(1)	-
Chromium	-	2	1	-
Cobalt	-	3	-	-
Copper	3	5	5	-
Iron	3(1)	6	4	-
Lead	3(1)	8(1)	7(1)	-
Manganese	1	4	-	-
Mercury	-	6	7	-
Nickel	2	4	1	-
Selenium	-	-	4	-
Silver	-	2	-	-
Vanadium	-	-	1	-
Zinc	3(1)	7(1)	8(1)	-
Pigments				
Chl a	17(3)	-	1(1)	3
Phaeo	2	-	-	2

TABLE 1.1 (continued)

FREQUENCY OF OCCURRENCE OF SELECTED CHEMICAL QUANTITIES FOR EACH SAMPLING MEDIUM

The numbers without parentheses are totals from both inventories (Volumes 4 and 22) and the numbers in parentheses are from this update only.

	Sea Water	Sediments	Biota	Ice Cores
Nitrogen-, Phosphorous-, Silica-based Nutrients				
Ammonia	4(2)	-	-	-
Nitrate	26(8)	-	-	2
Nitrogen	3(3)	-	-	-
Phosphate	31(8)	-	-	1
Silicate	26(9)	-	-	-
Urea	1(1)	-	-	-
Dissolved Gases				
Oxygen	34	-	-	-
Isotopes	2	-	-	-
C-H-N-P				
Carbon	1(1)	4	-	-
Part Carbon	2(2)	-	-	-
Suspended particles	3	-	-	-
Other				
Adenosine (III) phosphate	3(3)	-	-	-
Alk_t	1	-	-	-
Deoxyribonucleic acid	2(2)	-	-	-
Glycogen	-	-	1(1)	-
Lipids	-	-	1(1)	-
pH	3	-	-	-
Particle size	-	1(1)	-	-
Protein	2(2)	-	1(1)	-
Ribonucleic acid	2(2)	-	-	-

The inventory is ongoing. As new data and previously inaccessible data become available, they will be added to a computerized data base maintained at the Institute of Ocean Sciences, Sidney, B.C. Information about new data sets, older data sets which do not appear in this inventory or errors in this inventory, should be submitted in writing to the Institute of Ocean Sciences.

The following sections contain the rationale for organizing the data as it appears in the tables. Wherever possible, formats were adopted that were consistent with those used in the companion inventories of this series.

2. STUDY AREA

The study area is shown in Figure 2.1; it comprises about 100 000 km^2, approximately the same area as Baffin Bay or Hudson Bay. The marine channels of the Northwest Passage are usually ice-congested, even in summer. It was not until 1905, two years after entering Lancaster Sound, that the Gjoa, a seventy-two foot long converted herring boat commanded by Roald Amundsen, completed the Northwest Passage by sea (Mirsky, 1934).

The islands of the Canadian Archipelago are the exposed parts of the continental shelf which extends north from the mainland. The shores of the southern channels are composed of Precambrian rock of the Canadian Shield which extends up the Boothia Peninsula and Baffin Island. Glaciers covered much of the area during the last ice age. Raised beaches, resulting from isostatic rebound, are widespread today except for the west coast of Banks Island which appears to be sinking. Ice scouring is evident in the surface and submarine topography (Dunbar and Greenaway, 1956).

The marine channels of the Northwest Passage are the submerged portion of the continental shelf. Water depths exceed 500 metres in Lancaster Sound and M'Clure Strait; a sill of about 150 metres depth in Barrow Strait separates these two regions. Water depths in the southern channels are relatively shallow, about 50 metres. The waters of the Northwest Passage are a transition between the Arctic Water Mass to the west and Atlantic and Arctic waters to the east. The sill in Barrow Strait limits the easterly flow of Arctic water to the upper 150 metres of the water column. The warmer, more saline Atlantic water is found below the Arctic layer and usually occurs only in the deeper waters of eastern Lancaster Sound.

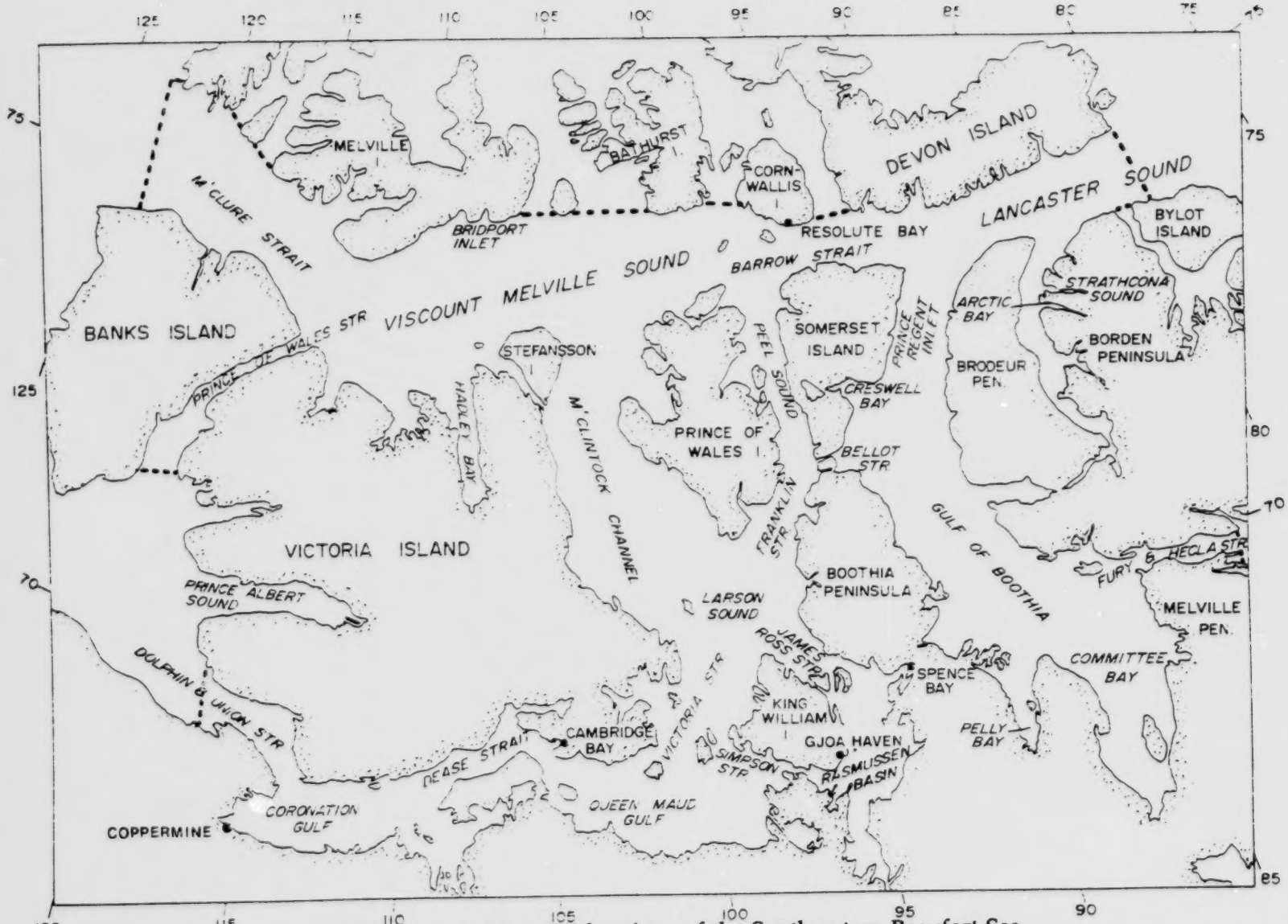


Figure 2.1 Arbitrary subregions of the Southeastern Beaufort Sea.

3. CHEMICAL DATA PRESENTATION

3.1 Types of Data

All chemical data have been grouped according to the environmental medium or compartment in which they are found, as follows:

Medium	Constituents Included
Water Column (Sea Water)	- dissolved constituents - particulate constituents
Sediments	- surficial sediments - sediment cores (interval sampling) - interstitial pore waters
Biota (flora and fauna)	- seawater dwelling organisms - bottom sediment dwelling organisms - marine mammals

The inventory includes all available data of a "chemical nature". This includes commonly measured substances such as major and minor elemental components and nutrients.

The largest amount and most diverse data are found for water column constituents. Field-based analyses of samples at the time of collection have been rare because most chemical analyses require specialized or sophisticated equipment. Water samples have been frequently processed in the field to the stage where sample preservation is convenient and then returned to the laboratory for analysis.

Other types of samples such as biota and sediments have been obtained in decreasing quantities respectively and all have been analysed exclusively in the laboratory after preservation for some extended period of time. A summary of the chemical data types included in the inventory is shown in Table 3.1.

TABLE 3.1

A SUMMARY OF CHEMICAL DATA TYPES INCLUDED IN THE DATA INVENTORY

The x's Represent Occurrences from the Previous Inventory (Volume 4) and the o's Represent Occurrences from this Update

	Sea Water	Sediments	Biota	Ice Cores
adenosine (III) phosphate (ATP)	xo			
alkalinity (total)	x			
ammonia	xo			
arsenic	x	x	x	
benzene extractable compounds	x			
cadmium	xo	xo	xo	
calcium carbonate		x		
carbon	xo			
carbonate	x			
carbon dioxide		x		
$^{13}C/^{12}C$ isotopic ratio	x			
particulate organic carbon (POC)	x			
total organic carbon (TOC)		x		
chlorophyll a	xo		o	x
chlorophyll b				x
chlorophyll c	x			x
total chlorophyll	x			
chromium			x	
cobalt		x		
copper	x	x	x	
deoxyribonucleic acid (DNA)	xo			
ethane, 2,2-Bis(p-chlorophenyl)-1, 1-dichloro- (i.e.p,p'-DDD)			x	
ethane, 1-(o-chlorophenyl)-1-(p-chlorophenyl)-2, 2,2-trichloro- (i.e. o,p'-DDT)			x	
ethane, 1,1-Bis-(p-chlorophenyl)-2, 2,2-trichloro (i.e.p,p'-DDT)			x	
ethene,Bis-(clorophenyl)dichloro- (i.e.DDE)			x	
ethene, 2,2-Bis(p-chlorophenyl)-1,1-dichloro- (i.e.p,p'-DDE)			x	
glycogen			o	

TABLE 3.1 (continued)

A SUMMARY OF CHEMICAL DATA TYPES INCLUDED IN THE DATA INVENTORY

The x's Represent Occurrences from the Previous Inventory (Volume 4) and the o's Represent Occurrences from this Update

	Sea Water	Sediments	Biota	Ice Cores
helium				
dissolved	x			
$^{3}He/^{4}He$ isotopic ratio	x			
hexane extractable compounds (HEC)	x			
hexachlorobenzene (HCB)			x	
hydrogen				
particulate organic	x			
iron	xo	x	x	
lead	xo	xo	xo	
lipids			o	
manganese	x	x		
mercury		x	x	
methyl	x			
methane	x			
neon	x			
nickel	x	x	x	
nitrogen	xo			
nitrate	xo			x
nitrite	x			
organic		x		
total dissolved (TDN)	x			
particulate organic (PON)	xo			
oil and grease	x	x		
oxygen				
dissolved	x			
$^{18}O/^{16}O$ isotopic ratio	x			
pH	x			
particle size		o		
phaeopigments	x			x

TABLE 3.1 (continued)

A SUMMARY OF CHEMICAL DATA TYPES INCLUDED IN THE DATA INVENTORY

The x's Represent Occurrences from the Previous Inventory (Volume 4) and the o's Represent Occurrences from this Update

	Sea Water	Sediments	Biota	Ice Cores
phosphorus				
phosphate	xo			x
soluble reactive	x			
total dissolved (TDP)	x			
polychlorinated biphenyls (PCB)			x	
protein	xo		o	
ribonucleic acid (RNA)	xo			
selenium			x	
silicate	xo			
silicon	x			
silver			x	
starch grains	x			
suspended particulate matter (SPM)	x			
tarballs	x			
tritium	x			
urea	o			
vanadium			x	
zinc	xo	xo	xo	

3.2 Concentration Units

Several different concentration units have been used over the years to report the chemical results for Northwest Passage data. In order to eliminate confusion and provide for ease of data comparison between data sets, the International System of Units (Systeme International, SI) has been used wherever possible. The trend toward worldwide use of SI units as a standard has been established by resolutions of the General Conference of Weights and Measures. In addition, the International Union of Pure and Applied Chemistry (IUPAC) endorses the exclusive use of SI units for chemical quantities. An important advantage of using SI units for chemical oceanographic and geochemical data is the ease by which mass fluxes and chemical budgets can be calculated and compared for various elements and chemical compounds.

Factors used to convert units found in original reports to SI units are listed in Table 3.2.

4. OUTLINE OF DATA INVENTORY ORGANIZATION

The data are organized into a chronological series of data sets beginning with the year 1979. Each data set comprises sampling or chemical measurements taken during a single cruise, or during a sampling excursion usually by a single agency. It is assumed, then, that data within a given data set have been collected uniformly and should be internally consistent insofar as sampling methodology is concerned.

TABLE 3.2

CONVERSION FACTORS AS NUMERICAL MULTIPLES OF SI UNITS

Chemical Quantity	to convert from*	to	multiply by
	litres	m^3	1,000
	$mg\ L^{-1}$	$g\ m^{-3}$	1
ammonia	$mg\ L^{-1}(NH_3)$	$mmol\ m^{-3}\ (NH_3)$	58.82
	$\mu g\ at\ L^{-1}\ (NH_3)$	$mmol\ m^{-3}\ (NH_3)$	1
arsenic	$\mu g\ L^{-1}$	$\mu mol\ m^{-3}$	13.35
	$\mu g\ g^{-1}$	$\mu mol\ kg^{-1}$	13.35
cadmium	$\mu g\ L^{-1}$	$\mu mol\ m^{-3}$	8.90
	$\mu g\ g^{-1}$	$\mu mol\ kg^{-1}$	8.90
calcium	$\mu g\ L^{-1}$	$\mu mol\ m^{-3}$	24.95
calcium carbonate	% (wt/wt)	$mol\ kg^{-1}$	0.0999
carbon	$\mu g\ g^{-1}$	$\mu mol\ kg^{-1}$	83.26
carbon dioxide	% (wt/wt)	$mol\ kg^{-1}$	0.227
chromium	$\mu g\ L^{-1}$	$\mu mol\ m^{-3}$	19.23
	$\mu g\ g^{-1}$	$\mu mol\ kg^{-1}$	19.23
cobalt	$\mu g\ L^{-1}$	$\mu mol\ m^{-3}$	16.97
	$\mu g\ g^{-1}$	$\mu mol\ kg^{-1}$	16.97
copper	$\mu g\ L^{-1}$	$\mu mol\ m^{-3}$	15.74
	$\mu g\ g^{-1}$	$\mu mol\ kg^{-1}$	15.74
p,p′-DDD	$\mu g\ L^{-1}$	$\mu mol\ m^{-3}$	3.13
	$\mu g\ g^{-1}$	$\mu mol\ kg^{-1}$	3.13
p,p′-DDE	$\mu g\ L^{-1}$	$\mu mol\ m^{-3}$	3.14
	$\mu g\ g^{-1}$	$\mu mol\ kg^{-1}$	3.14
p,p′-DDT	$\mu g\ L^{-1}$	$\mu mol\ m^{-3}$	2.82
	$\mu g\ g^{-1}$	$\mu mol\ kg^{-1}$	2.82
o,p′-DDT	$\mu g\ L^{-1}$	$\mu mol\ m^{-3}$	2.82
	$\mu g\ g^{-1}$	$\mu mol\ kg^{-1}$	2.82
iron	$\mu g\ L^{-1}$	$\mu mol\ m^{-3}$	17.91
	% Fe (w/w)	$mol\ kg^{-1}$	0.179
lead	$\mu g\ L^{-1}$	$\mu mol\ m^{-3}$	4.83
	$\mu g\ g^{-1}$	$\mu mol\ kg^{-1}$	4.83

TABLE 3.2 (continued)

CONVERSION FACTORS AS NUMERICAL MULTIPLES OF SI UNITS

Chemical Quantity	to convert from*	to	multiply by
manganese	$\mu g\ L^{-1}$	$\mu mol\ m^{-3}$	18.20
	% Mn (w/w)	$mol\ kg^{-1}$	0.182
mercury	$ng\ L^{-1}$	$nmol\ m^{-3}$	4.99
	$ng\ g^{-1}$	$ng\ kg^{-1}$	4.99
methane	$nL\ (STP)\ L^{-1}$	$nmol\ m^{-3}$	44.64
nickel	$\mu g\ L^{-1}$	$\mu mol\ m^{-3}$	17.03
	$\mu g\ g^{-1}$	$\mu mol\ kg^{-1}$	17.03
nitrogen	$mg\ L^{-1}$	$mmol\ m^{-3}$	71.43
	$mg\ kg^{-1}$	$mmol\ kg^{-1}$	0.0714
nitrate	$mg\ L^{-1}\ (NO_3)$	$mmol\ m^{-3}\ (NO_3\text{-}N)$	16.13
	$\mu g\ at\ L^{-1}\ (NO_3\text{-}N)$	$mmol\ m^{-3}\ (NO_3\text{-}N)$	1
nitrite	$mg\ L^{-1}\ (NO_2)$	$mmol\ m^{-3}\ (NO_2\text{-}N)$	20.83
	$\mu g\ at\ L^{-1}\ (NO_2\text{-}N)$	$mmol\ m^{-3}\ (NO_2\text{-}N)$	1
oxygen	$mg\ L^{-1}\ (O_2)$	$mol\ m^{-3}\ (O_2)$	0.0313
	$mL\ L^{-1}\ (O_2)$	$mol\ m^{-3}\ (O_2)$	0.0446
phosphate	$mg\ L^{-1}\ (PO_4)$	$mmol\ m^{-3}\ (PO_4\text{-}P)$	32.29
	$\mu g\ at\ L^{-1}\ (PO_4\text{-}P)$	$mmol\ m^{-3}\ (PO_4\text{-}P)$	1
phosphorous	$\mu g\ L^{-1}$	$mmol\ m^{-3}\ (P)$	0.0324
potassium	$mg\ L^{-1}$	$mmol\ m^{-3}$	25.58
selenium	$mg\ L^{-1}$	$mmol\ kg^{-1}$	0.0127
silicon	$mg\ L^{-1}\ (Si)$	$mmol\ m^{-3}\ (Si)$	35.60
	$mg\ L^{-1}\ (SiO_2)$	$mmol\ m^{-3}\ (Si)$	16.64
	$\mu g\ at\ L^{-1}$ (silicate-Si)	$mmol\ m^{-3}$ (silicate-Si)	1
vanadium	$\mu g\ g^{-1}$	$\mu mol\ kg^{-1}$	19.63
zinc	$\mu g\ L^{-1}$	$\mu mol\ m^{-3}$	15.30
	$\mu g\ g^{-1}$	$\mu mol\ kg^{-1}$	15.30

* **Note:**

In Table 2 conversions for dissolved constituents have been made assuming that the density of sea water is 1.00; i.e. that 1 $\mu g\ L^{-1}$ is equivalent to 1 $\mu g\ kg^{-1}$.

Each data set has been assigned an identification number of the form yy-nnnn, where yy = last 2 digits of the year in which data were collected and nnnn = order of identification for that particular data set for that year. The data set number is a unique identifier which applies throughout this series of inventories; for example, any data set identified as 80-0001 is the same no matter where the reference to it is made. In certain cases, data may have been collected over a period of months or years by a common study team with minor or major differences occurring in the types of data collected at each sampling period. When this occurred, letters were used as a suffix to the data set number to distinguish the various sample collections. For example, data set 82-0120 is divided into two parts in the inventory - 82-0120A and 82-0120B. While there is insufficient reason to regard the two as separate data sets because all samples were collected during a single season, the subdivision is made to emphasize that different parameters were sampled by two separate groups of scientists during the sampling period. Gaps may appear in the sequence of data set numbers in this inventory for a particular year, because each data set will not appear in every discipline and geographical area.

This inventory comprises three main tables followed by supporting figures and tables. Table 1 is a chronological list of data sets by data set number (see above). Table 2 is a summary of specific details for actual chemistry data. Table 3 is a listing of times and locations of individual measurements. Where station coordinates were not specified in reports, approximate station positions were obtained by measuring plotted station locations on figures located in the report. Measurement locations are plotted in a series of maps in Section 10. There are four standard maps; all are Lambert Conformal Conic projection. The map encompassing the study area is drawn to a scale of 1:7 000 000. The other three maps are drawn to a scale of 1:4 000 000; they yield better resolution of data sets containing closely spaced stations. In all cases, the coastlines have been smoothed and small islands removed to avoid clutter. In data sets where stations are very closely spaced, a single symbol is used to reduce smudging. In these cases, the number in parentheses to the right of symbol refers to the number of stations at the location represented by the symbol. To maintain uniformity and facilitate comparison, maps for all volumes in the Arctic data compilations have been drawn from common stock.

A listing of the geographic occurrence of data sets is given in the geographic index. Section 11.2 is an index of references ordered by data set number. The first (primary) reference shown for each data set is the original data report or similar document. The secondary references that follow are other reports or refereed papers

based on the primary reference. The listing of secondary references should not be considered an exhaustive literature search. Only those secondary references are included as were found while searching for original data set documents.

4.1 Description of Table Headings

4.1.1 Table 1

Table 1 provides general details of sampling excursions and includes:

(1) identification of the specific region within the study area where sampling was conducted;

(2) the period of time during which the measurements were made;

(3) the ship or agency which collected the data;

(4) a listing of the chemical parameters measured or sampled during the collection period;

(5) concurrent physical and biological measurements or samples.

4.1.2 Table 2

In Table 2, specific details including analytical results, are given for each quantity measured in each data set. These include:

(1) total number of stations sampled;

(2) total number of samples obtained at all stations;

(3) the number of samples having analytical results greater than the analytical detection limit or greater than 0 when 0 is used to designate the detection limit;

(4) methodology information: details of collection, storage (preservation), and analysis of the sample allowing for judging quality and comparability of data;

(5) the range of reported concentrations. Note that all concentrations are given in Systeme International (SI) units. Conversions between these and previously used units are given in Table 3.1;

(6) the mean and median of the reported concentrations. The median is included because it is not as easily influenced by extreme values as is the mean. It thus represents a better estimate of the middle of a sample population with skewed distribution. Many environmental parameters fall into a log-normal distribution, so the median is probably a better estimate of central tendency. If the number of observations is odd, the median is the middle one of the observations; if the number is even, the median is the average of the two innermost observations. Where a suite of results includes detection limit values samples that were beneath the detection limit were not included in the mean calculation;

(7) a data quality (confidence) rating based on the rules outlined subsequently (by Section 5.2). The data rating scale uses values from 0 to 4, with 4 indicating data judged to be of highest quality and most reliability (refer to Section 5.3).

4.1.3. Table 3

Table 3 provides specific spatial and temporal details for collected samples. These include:

(1) station position (latitude, longitude). For stations where no latitude/longitude are expressed, estimates were made by direct measurement of the plotted station points contained in individual original reports;

(2) station depth;

(3) sampling time (year, month, day and hour in GMT or local time);

(4) number of points (samples in profiles); and

(5) maximum depth sampled.

4.2 Sample Use of the Inventory

Example 1 Searching for specific-parameter data: e.g., metals in sea water

Step 1. Consult Table 1 and scan the column labelled "Chemical parameters measured or sampled". Note the data sets listing metals as a measured parameter.

Step 2. Consult the noted data set numbers in Table 2 to obtain specific details of sample history and reported concentrations.

Step 3. Refer to Table 3 for station positions, depths sampled, etc. If areal coverage of stations is of interest, go to Section 6 and consult maps for the data set(s) of interest. Maps are ordered chronologically.

Step 4. Consult the reference list for reports or publications upon which the data set is based.

Example 2. Searching for data from a specific geographic area: e.g. metals in Strathcona Sound sea water

Step 1. Consult Geographic Index. Note data set numbers.

Step 2. Consult Table 1 for data sets reporting metals in sea water.

Step 3. Continue as in Example 1.

When additional details concerning data are required, the original data sets must be consulted. Access to these documents may be obtained through the Data Assessment Division at the Institute of Ocean Sciences, Sidney, British Columbia.

5. DATA RATING SYSTEM

5.1 Data Quality Criteria

The reported chemical data for the Northwest Passage have been appraised using a rating system based on five data quality parameters related to methodology:

(A) sample collection;
(B) sample storage/preservation;
(C) sample analysis;
(D) analytical precision; and
(E) analytical accuracy.

These five parameters satisfy a fundamental requirement that the rating criteria allow an assessment to be made of any chemical result at any point in the history of a sample from collection to final analysis. In this way, the five parameters shown above represent a measure of the ultimate believability of results.

A quiet revolution has been taking place in recent years in the approach analytical chemists have for quality control and the establishment of well-defined performance criteria for analytical procedures. The most significant step was the general recognition that analytical quality control has been almost universally inadequate in the areas of environmental chemistry. The residual problem is resistance to change; routine analysis and reporting procedures that have been in use for many years will not change overnight. The new concepts as articulated by Taylor (1983), Kirchmer (1983), Long and Winfordner (1983), Glaser et al., (1981) and Cheeseman and Wilson (1978) will eventually be practised and improved by analytical chemists. This evolutionary process will lead to results for environmental chemical samples far superior to those summarized in this inventory.

A general caution is appropriate at this time. A great deal of chemical data has been collected over the years by biologists. The objective in sampling has often been to merely "get a rough idea of metal contents or hydrocarbon contents, etc." rather than produce state-of-the-art results. There is an insidious danger in this approach to chemical oceanography and science in general; namely, that it encourages a lower level of care in all aspects of the methodology chain which, when added together, leads to far greater errors than originally intended or considered to be within acceptable limits. For

this reason, all sampling teams should always strive for the best results within their capability rather than those somewhat below.

Some general concepts and comments related to the five data quality criteria introduced earlier which indicate how they can be used in the data evaluation are discussed below. A more detailed discussion for specific chemical constituents is given for Section 5.3.

A. Sample Collection

Sampling has traditionally received little attention and has been the weakest link in marine chemical measurements. The method of sampling is crucial, especially for heavy metals or trace hydrocarbons where baseline values are often at or near the detection limit of many analytical techniques. Very specific steps involving sample preparation and collection methodology must be followed with fanatical attention to detail so as to limit the effects of negative and positive contamination. These details are an integral part of the final reported number and must be specified with the results.

B. Sample Storage and Preservation

Once the sample is collected, it must be preserved in such a way that it remains representative of the water body, ice core, sediment, plant or animal from which it was collected or sampled. Storage containers are very important. For the storage of samples for the determination of heavy metals in sea water, for example, a severe hot acid pretreatment of plastic or Teflon storage bottles must be achieved. Bottles used for storing hydrocarbon samples must be cleaned with solvent and baked to rid the containers of contaminating substances. Procedures specifically applicable to samples for other chemical substances are often necessary. Certain types of samples for parameters which are sensitive to change through biological activity (e.g., nutrients, chlorophyll a, etc.) must be analysed or preserved immediately after collection before such activity begins to alter the sample irreversibly. Failure to do so will result in samples becoming unrepresentative of the original water mass. Acid is frequently used as a preservative for seawater samples for heavy metal analysis. Because the concentration of heavy metals is exceedingly low in sea water, only acids with the highest level of purity can be used, lest the acid addition introduce more metals into the samples than those occurring naturally. Consequently, the purity of all preservatives

must be carefully tested before use and must be specified in collection details. Length of time between collection and preservation should be reported exactly.

C. Analysis

Assessing the comparability of analytical results depends on a detailed description of the chemical protocol used. The protocol is a set of definitive directions that must be followed, without exception, if the analytical results are to be accepted for a given purpose. Protocol fits into the hierarchy of methodology as outlined by Taylor (1983) in the sequence **technique → method → procedure → protocol**. The simple statement found in many reports that "sterile procedures were used" or that "standard methods were used" does not provide enough information to form an opinion about the reliability of the technique employed or the validity of results obtained. This follows from the fact that most chemical laboratories dealing with the analysis of marine samples recognize that most procedures are not routine and that operational changes are often made. Thus, the instrumentation and analytical conditions employed; the quality and age of reagent chemicals; the values of reagent and procedural blanks; and the finesse of the analyst with the technique will be critical to the eventual outcome of the analysis. All these details must be specified. Also, quantitative proof that the analytical measurement is in control must be provided. Otherwise, the situation articulated by Eisenhart (quoted in Taylor, 1981) will probably be all too true: "Until a measurement operation .... has attained a state of statistical control, it cannot be regarded in any logical sense as measuring anything at all".

Detection Limits and Blanks

Important performance criteria of an analytical method are detection limit and blanks. Many definitions for the term "detection limit" can be found in the literature. A consensus appears near. In qualitative terms the limit of detection is the lowest concentration of an analyte that can be reliably distinguished from an analytical blank (Long and Winefordner, 1983). Over the years, the calculated limit of detection for an element has varied as much as an order of magnitude through the use of different statistical approaches and different interpretations of what detection limit really is. This has important implications for the chemical oceanographic data for the Northwest Passage because many data sets contain detection limit values or values reported simply as "less than detection limit" with the detection limit unspecified. No descriptions are

provided in any of the data sets in sufficient detail (in most cases zero detail) so that no data at the lower end of the reported ranges can be used with any degree of certainty.

Blanks are another performance criterion for an analytical process. Highly variable blanks lead to very poor estimates for the detection limit. The majority of data sets are inadequate in describing analytical blank procedures or values for the blanks. The combination of no information for the detection limit and blanks together with many data sets reporting variable detection limits leads to a situation where the data are uninterpretable. The data will probably remain so because there is no known algorithm which can transform incoherent data into coherent data.

D. Precision

Precision is a measure of random error. It is essential for defining significant intra-data differences and is usually expressed as the standard deviation of n analytical measurements. It is possible for an analytical result to be very precise but inaccurate. Precision should be determined for each procedure, type of sample and analyst. It is very important that the estimation of precision is made on "real" samples and not on reference materials. A description of how precision was measured must be provided. The value given for this parameter with a group of data must truly apply to the specific analysis used to produce those data and not simply be a statement of that which has been achieved or that which can be achieved or expected by others for the same or a similar analytical technique. Precision may be estimated by numerous replicated determinations on a sample. This, however, probably leads to a biased estimate since the analyst is apt to give greater care with samples known to be used to measure variance. A better estimate can be made by blindfold determination of several replicated samples (covering the range of concentration expected for the samples) run randomly throughout the period of analysis.

E. Accuracy

Accuracy is a measure of systematic error. As pointed out by Kirchmer (1983), there is a problem in defining accuracy because of the discrepancy between the accuracy of individual analytical measurements and the accuracy of average (long-run) values obtained from a number of replicate measurements (n must be specified). Common practice has been to define accuracy as the deviation of the mean of n measurements from the "true" value; this is the definition used here. Another school of thought applies

the term "bias" (equivalent to "systematic error") to the definition above and defines accuracy as the combined random and systematic errors of results. Systematic errors can arise from a variety of sources including:

- unrepresentative sampling;
- instability of samples between sampling and analysis;
- interference effects;
- biased calibration;
- a biased blank correction; and
- inability to determine all forms of the determinand.

It is clear that an accurate result can only occur after each of the above factors is defined quantitatively and precisely.

Accuracy can be estimated by comparing analytical results with the certified values for a reference material. Unfortunately, certified reference materials are available for only a limited number of elements or compounds in the various sample matrices or environmental phases. In practice, this means that the matrix of the reference material and that of the sample will rarely, if ever, be chemically equivalent. Consequently, when an analyst uses a reference material to validate an analytical procedure, the user of the data must judge whether the two matrices (sample and reference material) are sufficiently similar to warrant the use of the results for the reference material as evidence for the validity of the analytical results obtained for actual samples. A simple example illustrates this point: In judging the quality of an apple only another apple, which has been judged and certified to be of specified quality, can be used as a reference. An orange, no matter how good, will not do. The apple may, in fact, be of high quality but this cannot be established on the strength of information obtained using an inappropriate reference material (the orange). In the same way, results for heavy metals in seal livers, for example, cannot be validated using National Bureau of Standards Reference Material 1571 (Orchard Leaves). At the very least, the lipid and oil content of the liver tissue would lead to chemical interferences far greater than those likely to occur with orchard leaves. The degree of interference will be specific to the analytical method; therefore, when assessing the quality of a data set, the experience of the scientist is very important for establishing criteria for accepting/rejecting reference materials in a given situation according to the specific details of each analysis. In cases where the matrix of the reference material used to validate the method and estimate accuracy is judged to be sufficiently different from that of the sample so as to make the results obtained for the

reference material irrelevant for assessing the quality of the sample data (see additional information, Section 5.1 E). In these cases the maximum rating score is 2. Examples of inappropriate use of reference materials are (1) use of National Bureau of Standards SRM 1577 (Bovine Liver), National Bureau of Standards SRM 1566 (Oyster tissue) or National Bureau of Standards RM 50 (Tuna) to validate seaweed analyses and (2) use of National Bureau of Standards SRM 1571 (Orchard Leaves) to validate seaweed, fish and mammal tissue analyses.

When satisfactory reference materials are not available, accuracy of a method is sometimes estimated by measuring the ability of the method to recover a standard spike added to a portion of the sample or added to a material having a matrix similar to that of the sample. This method may fail to provide a reliable estimate of analytical accuracy because the added standard may not have a chemical reactivity which is equivalent to the component in the sample; it may, therefore, respond differently to the chemical steps involved in the determination. While this method of additions cannot prove that an analytical procedure is accurate, it can (by demonstrating poor and highly variable recoveries) identify methods that are inherently imprecise. When certified reference materials or standards are used, standardization should be blindfold and occur at random with replication to avoid biased results caused by analysts who pay special attention to standardization samples and who know or are likely to guess the established reference material composition. In addition, more than one reference material should be used to validate a given method whenever possible. This may identify matrix interferences that go unnoticed using a single matrix. When systematic errors are found (under or over-recovery of the determinand) the results should be reported without correction for recovery data because the application of a correction factor may do little beyond replacing one wrong estimate with another.

Alternatives are available for demonstrating analytical accuracy. Agreement of results determined using different analytical methods employed by different laboratories during intercalibration exercises is one way of increasing confidence in the results. Although reference materials and intercalibrated results may generate confidence in an analytical result, they still can not prove whether the value obtained is an accurate representation of the true value in the environment. Satisfactory agreement among triplicate samples, consistently low blanks and results that make sense (and are consistent with other supporting measurements) will increase confidence.

It is important to distinguish between reference materials and primary standards. The chemical composition of a reference material is empirically derived from the pooled analytical results of several laboratories using different methods and

instruments for the assay. Values for reference materials are commonly described as certified values, recommended values or average compositional values. By contrast, primary standard values are "true" values and are independent of the method of analysis. They are inherently more reliable than the values "recommended" for reference materials. A more detailed discussion of "standard" samples can be found in the review by Abbey (1980).

5.2 Definition of the Rating System

All data have been rated by a 5-level rating system, defined as follows.

Rating Score	Data Quality
0	data are found (or judged) to be wrong or unrepresentative Example: seawater samples collected in metal Nansen bottles with metal content as the intended analysis.
1	data are suspect because of ill-defined doubts Example: magnitude of results falls outside previous scientific experience (see Preface notes to Tables 1 and 2 for further details).
2	insufficient information to assess data; data were not investigated (where data no longer exist, an explanation is entered in remarks column)
3	data are internally consistent; patterns or trends within data are probably real but comparison with other data sets may be a problem (because of incomplete or improper standardization)
4	data are internally consistent and are sufficiently standardized or tied to a reference that comparison with other data at this rating score should be possible. (Data may not be accurate in an absolute sense because all data may be defined relative to a reference material having a different matrix.)

This rating system can be criticized for not being hierarchical because the 2 rating score is misplaced. An hierarchical rating scheme can be produced, however, by rearranging the rating scores in the order 2, 0, 1, 3, 4. It is suggested that this re-ordering of data

quality levels be used by those more comfortable with an hierarchical scheme rather than creating a new rating system. This will avoid the confusion of several rating schemes within the data inventory series and provide continuity with the inventories already published.

This rating system is intended as a guide and not an absolute statement of data quality; it is one of several ways to represent the quality of acquired chemical data. The ideal rating system would use only objective criteria. This is, however, not possible because of the lack of standard analytical procedures in use and because of the significant changes in sample collection and storage techniques and philosophy that have occurred in recent years. Consequently, a certain subjectivity is inherent in the appraisal of data and any given system for objective data quality appraisal is almost doomed to fail as soon as it is chosen because it will rely to some degree on the discretion of the appraiser.

Ultimately, the quality of the data will reflect the weakest link in the methodology chain (see 5.3 below). Thus, in cases where a deviation from acceptable methodology is considered so serious that the validity of the obtained results is in doubt, a value of 0 is assigned. Consider the collection of seawater samples for heavy metal analyses, for example. Suppose that the samples were stored acidified in unprepared PVC bottles. During the storage period some metals would leach out of the PVC material which forms the walls of the bottle, introducing positive contamination to the sample. Because all sampling bottles can differ slightly and sometimes greatly in their composition of impurities, the magnitude of the contamination can be random among samples, so that not even comparison of concentration values within the sample set can be justified in a relative sense. The clear lack of confidence in the results together with the strong suspicion that the samples are no longer representative of the original water mass would result in the assignment of a data rating value of 0. It should be noted that the chemical analyses could have been carried out with well-accepted analytical techniques using the finest state-of-the-art instrumentation. In fact, the analyses could be very precise and very accurate based on the analysis of certified reference materials. Unfortunately, despite the excellence of the analysis, the results would still be hopelessly wrong. With reference to this inventory of chemical oceanographic data for the Northwest Passage, cases as obvious as the example above were rare. The most common characteristic of the data sets was an insufficient description of how the results were generated. This led to the assignment of a data rating of 2 to the majority of data sets. It must be stressed, however, that a 2 rating is no better than a 0 rating unless missing information is supplied. If that information no longer exists or in fact never

existed, a 0 rating would be warranted. Those readers interested in data sets rated 2 or below are advised to inspect the data very carefully and investigate the data to a level required by the use to which they intend to put the data.

As already noted, merely stating that a given analytical method was used for a chemical analysis is not sufficient information to reach an opinion about the quality or validity of the data. The quality of analysts varies widely. What can be attained by one analyst can be beyond the abilities of others even when "identical" procedures are employed as demonstrated on more than one occasion during inter-laboratory calibration exercises.

5.3 Significance of the Data Rating Value

The usefulness of the data will depend on the use for which the data are intended, i.e., which question or environmental concern is being considered. The data rating value may be seen to separate groups of data; this can lead to different degrees of understanding environmental processes. It should be recognized that the rating system is not specific to chemical data. Rather, the system seeks to distinguish fundamental differences in information such as those data sets which contain invalid data; those which limit comparisons of numbers to within themselves; and those which allow comparison between data sets.

At least three levels of data quality are essential to establish significance of data:

Level 1: Identification of Ranges of Values

At this least discriminating level, the data can be assessed for whether or not their reported ranges fall within the general limits expected for coastal or estuarine areas. Gross errors, contamination, or methodology problems would be identified. Even if the ranges of data were physically possible, this level of data scrutiny does not provide any site-specific information, or determine whether the data were representative of a given geographic area, depth or particular time of year when the data were collected. Most data, even data scoring 1 or 2, could be tentatively used in such a way.

Level 2: Comparison of Data within the Data Sets

At this level, comparison of profiles or time series within a given data set could be used to determine whether measurements of water or sediment properties at particular stations were significantly different from each other on the basis of precision of measurement. Data with a rating of 3 could be used in this instance provided the precision was sufficient to resolve differences within the range of measured values.

Level 3: Comparison of Data Between Data Sets

This is the minimum rating level required for studies of long-term variability of chemical components. It is also required for studies describing processes that control lateral and vertical distributions of chemical components. Studies involving the detection of subtle shifts in chemical equilibria that may lead to downstream effects (such as perturbations to biological systems or climatological changes) also require data with a high level of confidence and a measure of absolute accuracy. Only data with a rating of 4 could be considered for such applications, but will be inadequate when the samples are not representative of the environmental medium sampled. Full interpretation of chemical oceanographic data is impossible in isolation from knowledge of water column structure. Thus, when concurrent measurements of temperature, salinity and perhaps nutrients and dissolved oxygen or some other related variable are not available to support the chemical data, even 4-rated data will be of limited value. In such cases, conclusions will be tentative, being based primarily on inference and conjecture.

5.4 Effect of Positioning on the Data Quality

Accuracy of the station positions is a factor essential to the proper use of the data inventory. This is particularly relevant when knowledge of spatial distributions of water or sediment properties are essential for the understanding of a particular oceanographic phenomenon. Many station positions were obtained using rudimentary techniques such as dead reckoning, or radar range and bearing at distances far from shore; consequently, there may be considerable uncertainty about the geographical location at which samples were obtained. This leads to the dilemma that some chemical data which have received a 4-rating may in fact be of little value in defining important spatial distributions.

Data sets for which no details of positioning or position co-ordinates were given are designated by the term NPG (No Position Given) in the remarks column of Table 2. Entries for these positions appearing in Table 3 were estimated graphically from original report figures and are so indicated and are intended as a very rough guide only.

5.5 Some Important Factors Relevant to the Data Appraisal Process

The sampling and sample processing techniques used in chemical oceanography are not universally applied to all parameters. Reliable results for certain parameters require the successful application of stringent and highly specialized precautions, while reliable results can be obtained for others using standard routine methodologies. Following is a brief discussion of factors that one must consider when evaluating data and examples of difficulties that can occur during processing of samples for the most commonly observed parameters in Table 2 (heavy metals, nutrients).

5.5.1 Heavy Metals

A. Sea Water

Many of the pitfalls associated with obtaining reliable heavy metal data in sea water can be illustrated by following the history of a water sample from the time of collection through to the completion of the analysis.

The first step facing the chemical oceanographer is the collection of a representative sample. Although this is probably the most important link in the chain of analytical operations, historically it has been given far less thought and care than it deserves. The sampling device must be constructed of materials that will not contaminate the sample. Thus, all metallic components of commonly used samplers must be removed or replaced. In addition, samplers must be thoroughly cleaned and kept clean between sampling casts. Teflon is an excellent construction material for samplers because it is usually manufactured with only very low trace metal impurities and can be hot acid cleaned. Samplers made from this material must be carefully cleaned, however, because during the fabrication of Teflon into a chemical apparatus, particles of grit, rust and dirt may become embedded in the surface to act as a source of contamination for long periods of time. The standard Niskin-type water sampler (which has been used extensively in Beaufort Sea sampling) usually contains an internal

rubber-coated metal spring or rubber shock cord as part of the closing mechanism. Both are unacceptable since metal impurities can be present in these materials (for example zinc oxide at percent levels). Thus, the use of these samplers for the collection of seawater for zinc analysis is not recommended unless the standard internal spring has been replaced by a Teflon-coated spring or similar contamination-reducing component. Because the sea surface microlayer is enriched with heavy metals, it is advisable to obtain subsurface seawater samples by using samplers such as the Niskin GO-FLO sampler that passes closed through the sea surface layer. Peristaltic pumping systems employing acid-cleaned polyethylene or Teflon tubing have also been used to avoid some of the contamination associated with the surface layer and general handling but these are usually practical only for shallow depths.

The necessity for carefully choosing a sampler is clearly apparent from the results of recent sampler intercomparison studies. Spencer et al. (1982) report that surface water samples taken with a Teflon-coated Niskin GO-FLO sampler possessed much higher concentrations of zinc (7-10 fold) and lead (2-3 fold) than those collected directly in Teflon bottles. Bewers and Windom (1982) compared GO-FLO, Niskin and Hydro-Bios samplers. Their results show that the seawater samples which had lower concentrations of metals (Cd, Cu, Ni, Zn, Fe, Mn, Hg, Mo, and V) were collected using GO-FLO bottles in which O-rings and seals were replaced by silicone equivalents; drain cocks were replaced by those made of solid Teflon. Modified Niskin samplers appeared to be only slightly inferior to the modified GO-FLO, but unmodified GO-FLO and Hydro-Bios samplers were generally poorer.

Other precautions that should be observed during the collection of seawater samples for heavy metal analyses include:

(i) use of plastic-coated steel rope, Kevlar rope or stainless steel wire rope in place of the standard iron hydrographic wire (Bewers and Windom, 1982);

(ii) stainless steel weights wrapped in plastic to weigh the hydrographic wire;

(iii) obtaining surface samples from a small boat by heading into the wind against local surface currents and holding the sample bottle so that it precedes the boat through the water.

Once collected, the sample must be transferred to a storage bottle for some period of time. The storage container must be prepared before use to reduce the possibility of the bottle contaminating the sample. This usually involves a multi-stage and multi-day hot acid-cleaning procedure as described by the Participants of the Lead in Seawater Workshop (1976). Cleaned containers are stored wrapped in polyethylene film and handled only with polyethylene-gloved hands. A preservative is usually added to the samples to inhibit biological activity and the absorption of heavy metals onto the walls of the storage containers. The preservative is most often HCl and must be of sufficient purity to ensure that any trace metal impurities associated with the addition of acid are insignificant relative to the quantity of metal present in the sample.

Most heavy metals samples can be stored in Teflon, polyethylene or quartz when properly cleaned. Mercury should not be stored in polyethylene because mercury vapour readily passes into and through the walls of these containers. The question of whether the sample should be filtered before acidification is controversial. The procedures involved during filtration (particularly on a dirty ship or other field environment where laboratory conditions are not easily reproduced) may often result in greater contamination than would otherwise result from the acidification of unfiltered samples. Sometimes filtration cannot be avoided. On these occasions, filtrations should be carried out (a) under reduced pressure in a closed system apparatus which allows the sample to flow directly from the sample bottle through a pre-cleaned filter into a second pre-cleaned storage bottle or (b) using positive pressure (compressed filtered N_2) in a device that allows direct filtration of a sea water sample from the sampler into a storage bottle. Ideally, the elapsed time between sample collection and analysis should also be minimized to reduce the possibility of sample modification during storage. For instance, prolonged storage may favour the formation of very strong or kinetically-hindered metal complexes with naturally-occurring chelating agents which may, in turn, prevent the formation of an extractable complex with a chelating agent, inhibit a colour forming reaction or impede the reduction of an ion at an electrode. The ultimate result may be that normal analytical methods produce low results or miss a component entirely.

The analytical methodology must also be considered in view of current practices. Any analytical method may be internally consistent yet produce vastly different results from another method, making intercomparison difficult. An example is reported by Brewer and Spencer (1970) where results for the determination of cobalt in sea water obtained from the chelation/extraction/atomic absorption method were five to six fold greater than those obtained by neutron activation of the freeze-dried salts of replicate samples. Even primary reference standards may not be able to resolve such a

discrepancy because of matrix interferences, for example. Contamination arising during analysis from atmospheric fallout, reagents, sample handling, etc. must also be controlled. The recent trend toward performing heavy metal analyses in laminar flow work stations or Clean Rooms is understandable. Even so, it is not unusual to find members of the most advanced and prestigious marine analytical laboratories in the world disagree with each other by factors of 5 or more on the concentrations of metals in standardized sea water samples during international intercalibration exercises (Sugawara, 1978; Bewers et al., 1981; Olaffson, 1982). Deviations from the standardized or accepted values can exceed $\pm$100% in these intercalibration studies.

The facts presented above emphasize several important points. Steps should always be taken to limit handling and the addition of preservatives to samples. It is also very difficult to form an objective opinion about the quality of a trace metal data set when details such as the ones described above are not given. A true perspective of the heavy metal data as a whole can be achieved by considering the scientists' awareness of problems associated with sampling, storage and sample handling at the time the samples were collected. As the importance of controlling contamination became evident over the years, more effort has been made to systematically eliminate or reduce as many sources as possible. The result has been a continued decrease in the reported values for heavy metals in sea water since 1942 (see Table 5.5.1).

TABLE 5.5.1

BASELINE CONCENTRATIONS OF SELECTED TRACE METALS IN OPEN-OCEAN WATERS REPORTED DURING THE LAST FORTY YEARS

REFERENCE	UNITS	Cd	Cu	Pb	Zn	Ni
COMPILED DATA						
Sverdrup et al., 1942	μmol $tonne^{-1}$	present	157	1.9	85.0	—
Goldberg, 1965	μmol m^{-1}	0.98	47	0.14	153.0	—
Brewer, 1975	μmol m^{-3}	0.89	7.9	0.14	75.	—
ORIGINAL DATA						
Zirino and Healy, 1971	μmol m^{-3}	—	—	—	26.0	—
Chester and Stoner, 1974	μmol m^{-3}	0.62	12.6	—	21.0	—
Patterson, 1974	μmol m^{-3}	—	—	0.07	—	—
Bender and Gagner, 1976	μmol m^{-3}	<0.90	1.9	—	—	—
Eaton, 1976	μmol $tonne^{-1}$	0.53	—	—	—	—
Bruland et al., 1978	μmol m^{-3}	—	—	—	0.15 - 9.2	—
Kremling and Petersen, 1978	μmol m^{-3}	0.03 - 0.04	1.6 - 2.7	—	0.76 - 2.0	—
Windom and Smith, 1979	μmol $tonne^{-1}$	—	0.3 - 5.2	—	—	—
Bruland, 1980	μmol $tonne^{-1}$	0.002 - 1.11	0.54 - 5.3	—	0.08 - 9.1	—
Danielsson, 1980	μmol $tonne^{-1}$	0.07 - 0.84	1.3 - 5.5	0.10 - 0.82	—	3.1 - 16.2
Boyle et al., 1981	μmol $tonne^{-1}$	<0.01 - 0.08	0.05 - 1.5	—	—	1.03 - 3.5
Heggie, 1982	μmol $tonne^{-1}$	—	2 - 25	—	—	—

B. Sediment and Biological Tissues

In general, the pitfalls encountered in the sampling, storage and analysis of marine sediment samples are fewer than those encountered with sea water samples because the concentrations are commonly about three orders of magnitude higher. Obtaining a representative sample still remains a challenge. Many grab samplers such as the Ponar, screen top Van Veen, Petersen and Kahl box sampler collect substrate together with overlying water. Extreme care must be taken that the overlying water does not wash out the fine material within the surface layer during removal of sediment sample from the sampling device. Before sample collection, it is wise to consider the types of analyses that will be performed on the sample so that a suitable subsampling strategy can be devised. Walton (1978), for example, suggests that material from the outer portions of the sample can be used for physical analyses, whereas interior material which is more protected from disturbance or contamination can be used for metal or hydrocarbon analyses. Subsampling for one type of compound should not contaminate the remaining sample before removing a subsequent subsample. Some analysts prefer to analyse a subsample from a homogenized whole sediment; others analyse a given grain size fraction. Because trace metal content usually increases with surface area of particles, intercomparison of many data sets is often tenuous when different size fractions have been analysed. Also, errors may result when sieves made from copper or brass cloth are used to segregate grain sizes. For the analysis of heavy metals in benthic biota it is important that the animals be purged of gut contents before analysis, lest the inorganic sediment present in the gut be included in the estimation of biological metal. For small specimens it is often possible to obtain more reliable results by digesting the whole specimen(s) and subsampling the digest as opposed to subsampling the specimens before the digestion step. For larger animals such as fish and marine mammals, specific organs are usually examined due to the vast range of values possible for various body organs. Special precautions must be taken to check for interferences resulting from the presence of natural oils.

For both sediment and biological metals, methods involving conditions which favour the formation of covalent halides (e.g., hot sulphuric, perchloric or phosphoric acid in the presence of halide ions) should be examined carefully, given the possible quantitative distillation of chromium, arsenic, antimony, tin, selenium, rhenium and osmium and the vaporization of substantial amounts of germanium, molybdenum and mercury under such conditions, particularly when Teflon digestion bombs are not employed in the procedure.

5.5.2 Nutrients

The measured concentration of a given nutrient in a sea water sample is very dependent on analytical methodology. The term "reactive nutrients" is often used to emphasize that results refer to those quantities of nutrient that react under the conditions of specific analytical methods. Phosphate is usually measured as soluble inorganic orthophosphate ions which react with acidified molybdate reagent to yield a phosphomolybdate complex which is then reduced to a highly coloured blue compound. Currently used methods for ammonia determination (such as the indophenol blue method) usually measure NH_3 plus NH_4+. Earlier methods included varying amounts of labile organic nitrogen compounds such as trimethylamine and amino acids in the determination. Nitrite is determined as an azo dye formed by the stepwise stoichiometric reaction of nitrite ion with an aromatic amine. Nitrate is determined by the same method as nitrite after passing the sample through a catalytic reductor column to reduce nitrate to nitrite. Since many procedures do not measure nitrite separately, the results for nitrate would more accurately be stated as nitrate plus nitrite. The error involved is usually not significant, however, because nitrite is present only at about 5% of the concentration of nitrate. Silicon is determined as dissolved inorganic silicate based on the formation of a yellow silicomolybdic acid when an acidic sample is treated with molybdate solution. Colloidal silicic acid in sea water usually reacts, but polymeric chains containing three or more silicic acid units react very slowly.

The procedures used for sampling and storage of nutrients in sea water are often modified for specific applications. Some general points are noteworthy:

(a) for best analytical results, samples should be analysed within about one hour of collection;

(b) short-term storage should be in a cool, dark place;

(c) if long-term storage by freezing is necessary, it should be limited to a maximum of two months to limit variance caused by storage (Macdonald and McLaughlin, 1982);

(d) quick-freezing is an effective method for long-term storage of all nutrients except for silicate in estuarine water having a salinity of less than 27×10^{-3}. Caution must also be observed for samples containing silicate in excess of ca 70 mmol m^{-3} or stored for longer than five months. In these cases, data may be successfully recovered provided that thaw times are long enough. The addition of preservatives to

samples should be avoided to reduce the chance of contamination and possible interference with the analytical technique. In particular, acidification of phosphate samples is not recommended because of the tendency to favour hydrolysis of combined phosphorus. The addition of chloroform to phosphate samples should also be avoided, because this requires a preliminary sample filtration step which should be avoided if possible. Where water is visibly turbid, PO_4 samples must be filtered. This is particularly important in estuarine samples;

(e) silicate samples must be stored in plastic; phosphate samples keep best in plastic as uptake of phosphate by glass surfaces has been observed; nitrite/nitrate samples can be effectively stored in glass or plastic;

(f) before analysis, silicate samples should be thawed for a minimum of three hours to allow for depolymerization (exact time depends on length of time stored in the frozen state).

Although nutrient elements have been analysed frequently by many laboratories for many years, they cannot be routinely determined with sufficient confidence to resolve differences in nutrient water column structure. This is illustrated by the results of a 20-nation nutrient method intercalibration exercise conducted by ICES (International Council for the Exploration of the Sea, 1977) which showed that only 9% of the total variance of laboratory values was attributable to the "within laboratory" component of variance. Thus, the ability of each laboratory to obtain a precise result was much better than the overall accuracy observed during the intercalibration exercise. Coefficients of variation (CV) for the determination of the different nutrients ranged from 4% to 21%. Because the intercalibration was not a blindfold test, these CV's probably overestimate the precision that would be expected under routine laboratory conditions.

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7. DATA INVENTORY TABLE 1

NOTE: Entries appearing in column 5 indicate those chemical parameters which are reported in Table 2. Entries which are underlined refer to the medium sampled.

LIST OF ABBREVIATIONS USED IN TABLES 1 and 2

AAS	-	atomic absorption spectrophotometry (this general term used when it is not known whether instrument was used in flame (FAAS) or graphite furnace (GFAAS) mode)
Ag	-	silver (AW = 107.88)
AgDDC	-	silver diethyldithiocarbamate
Alk_t	-	total alkalinity
AOACMA	-	Association of Official Analytical Chemistry Methods of Analysis
AOL	-	Atlantic Oceanography Laboratory (of the Bedford Institute of Oceanography)
APDC	-	ammonium pyrrolidine dithiocarbamate
AS	-	Absorption Spectroscopy
As	-	Arsenic (AW = 74.92)
ATP	-	adenosine triphosphate
ATP	-	adenosine (III) phosphate
AuA	-	auto analyser
B	-	boron (AW = 10.81)
BEC	-	benzene extractable compounds
BIO	-	Bedford Institute of Oceanography
BT	-	bathythermograph
C	-	carbon (AW = 12.01) or conductivity when located in concurrent physical measurements column
$\delta^{13}C(°,oo)$	-	$^{13}C/^{12}C$ isotopic ratio
$CaCO_3$	-	calcium carbonate
CH_4	-	methane
CO_2	-	carbon dioxide
CO_3	-	carbonate
Ca	-	calcium (AW = 40.08)
CCl_4	-	carbon tetrachloride
Cd	-	cadmium (AW = 112.40)
$CHCl_3$	-	chloroform
CHL a	-	chlorophyll a
Chl. a	-	chlorophyll a

Chl. b	-	chlorophyll b
Chl. c	-	chlorophyll c
ΣChl.	-	total chlorophyll
Cl	-	chlorine (AW = 35.45)
CL	-	confidence level
Co	-	cobalt (AW = 58.94)
Cr	-	chromium (AW = 52.00)
CTD	-	conductivity-temperature-depth
Cu	-	copper (AW = 63.55)
CVAAS	-	cold vapour atomic absorption spectrophotometry
DDDC	-	diethylammonium diethyldithiocarbamate
DDE	-	bis-(chlorophenyl)-1,1-dichloroethene (F.W. = 318)
dl	-	detection limit
DNA	-	deoxyribonucleic acid
DOC	-	dissolved organic carbon
DOE	-	Department of the Environment
DWB	-	dry weight basis
p,p'-DDD	-	2,2-Bis(p-chlorophenyl)-1,1-dichloroethane (F.W. = 320)
p,p'-DDE	-	2,2-Bis(p-chlorophenyl)-1,1-dichloroethylene (F.W. = 318)
o,p'-DDT	-	1-(o-chlorophenyl)-1-(p-chlorophenyl)-2,2,2-trichloroethane (F.W. = 354.5)
p,p'-DDT	-	1,1-Bis-(p-chlorophenyl)-2,2,2-trichloroethane (F.W. = 354.5)
ECGC	-	electron capture gas chromatography
EDTA	-	ethylene diamine tetra acetate
EEP	-	electric eye photometer
evap	-	evaporation
FAAS	-	flame atomic absorption spectrophotometry
Fe	-	iron (AW = 55.85)
$Fe(OH)_3$	-	iron (III) hydroxide
FIDGC	-	flame ionization detector gas chromatography
FS	-	fluorescence spectroscopy

GC	-	Gas chromatography
GCMS	-	gas chromatography - mass spectrometry
GFAAS	-	Graphic furnace atomic absorption spectrophotometry
GLC	-	gas liquid chromatography
^3H	-	titrium
H_2SO_4	-	sulphuric acid
HC	-	hydrocarbons
HCB	-	hexachlorobenzene (F.W. = 284.78)
HCl	-	hydrochloric acid
$HClO_4$	-	perchloric acid
He	-	helium
δ^3 He (°/oo)	-	$^3H/^4$ He isotopic ratio
HEC	-	hexane extractable compounds
HF	-	hydrofluoric acid
Hg	-	mercury (AW = 200.59)
HNO_3	-	nitric acid
HPLC	-	high performance liquid chromatography
HTGC	-	high temperature gas chromatography
K	-	potassium (AW = 39.10)
K.B.	-	Ken Bruland Sediment Sampler
LWB	-	lipid weight basis
Me-Hg	-	methyl mercury
Mg	-	magnesium (AW = 24.31)
$MgCO_3$	-	magnesium carbonate
MIBK	-	methyl isobutyl ketone
Mn	-	manganese (AW = 54.94)
MS	-	mass spectrometry

N	-	nitrogen (AW = 14.01)
N/A	-	not applicable
Na	-	sodium (AW = 22.99)
$NaBH_4$	-	sodium borohydride
NBS	-	National Bureau of Standards (U.S.A.)
NC	-	not computable
Ne	-	neon
NH_3	-	ammonia
Ni	-	nickel (AW = 58.71)
NO^2	-	nitrite nitrogen
NO_3	-	nitrate nitrogen
NS	-	not specified
$\delta^{18}O$ (°/oo)	-	$^{18}O/^{16}O$ isotopic ratio
O_2	-	dissolved oxygen
OC	-	organic carbon
ON	-	organic nitrogen
P	-	total phosphorus
Part-C	-	particulate carbon
Part-N	-	particulate nitrogen
Pb	-	lead (AW = 207.19)
PCB	-	polychlorinated biphenyls
PE	-	polyethylene
pH	-	-log H^+
PHAEO	-	phaeopigments
POC	-	particulate organic carbon
PO_4	-	phosphate - phosphorus
POH	-	particulate organic hydrogen
PVC	-	polyvinyl chloride
Rb	-	rubidium (AW = 85.47)
RNA	-	ribonucleic acid

S	-	salinity
S & P	-	Strickland and Parsons
S/S	-	stainless steel
SCUBA	-	self-contained underwater breathing apparatus
SD	-	standard deviation
Se	-	selenium (AW = 78.96)
SF	-	spectrofluorometry
sfc	-	surface
SiO_3	-	silicate
SMOW	-	standard mean ocean water
SPM	-	suspended particulate matter
SRP	-	soluble reactive phosphorous
T	-	temperature
TC	-	total carbon
TDN	-	total dissolved nitrogen
TDP	-	total dissolved phosphate
TDS	-	total dissolved solids
TIC	-	total inorganic carbon
TLC	-	thin layer chromatography
TOC	-	total organic carbon
TSPM	-	total suspended particulate material
TU	-	tritium units (=1 $^3H/10^{18}H$)
UV	-	ultraviolet
V	-	vanadium (AW = 50.94)
V_2O_5	-	vanadium pentoxide
VS	-	visible spectroscopy
WT	-	Winkler titration
WWB	-	wet weight basis
Zn	-	zinc (AW = 65.37)

LIST OF PARAMETERS AND CHEMICAL QUANTITIES

Parameter: Hydrocarbons

Hexane/Benzene extractable compounds
Methane
Oil
Pesticides
Polychlorinated biphenyl
Tar

Parameter: Metals

Ag
As
Cd
Co
Cr
Cu
Fe
Hg
Mn
Ni
Pb
Sn
V
Zn

Parameter: Pigments

Chl a
Phaeo

Parameter: Nitrogen-, Phosphorous-, Silica-based Nutrients

SiO_3
SiO_2
SiO_4
N
NH_3
NO_3
PO_4
Urea

Parameter: Dissolved Gases

O_2

Parameter: C-H-N-P

C
Part-C
Part-N

Parameter: Other

Adenosine (III) phosphate
Alk_t
Deoxyribonucleic acid
Glycogen
Lipids
pH
Particle size
Protein
Ribonucleic acid

DATA SET I.D.	COLLECTING AGENCY, SHIP: Sponsor	COLLECTING PERIOD	AREAS	CHEMICAL PARAMETERS MEASURED OR SAMPLED	CONCURRENT PHYSICAL MEASUREMENTS	CONCURRENT BIOLOGICAL MEASUREMENTS	REMARKS
79-0126	MARINE ECOLOGY LABORATORY BEDFORD INSTITUTE OF OCEANOGRAPHY CCGS Louise S. St. Laurent	07/29/79 09/17/79	Lancaster Sound	Sea water: Pigments Nitrogen-, Phosphorous-, Silica-based Nutrients C-H-N-P Other			
80-0115	MARINE ECOLOGY LABORATORY BEDFORD INTITUTE OF OCEANOGRAPHY CSS Hudson	07/14/80 08/29/80 08/29/80	Lancaster Sound	Sea water: Pigments Nitrogen-, Phosphorous-, Silica-based Nutrients C-H-N-P Other			
82-0003	ARCTIC SCIENCES LTD. Institute of Ocean Sciences	03/19/82 04/06/82	Viscount Melville Sound	Sea water: Nitrogen-, Phosphorous-, Silica-based Nutrients	Water Column: CTD, S		
2-0004	OCEAN PHYSICS INSTITUTE OF OCEAN SCIENCES	03/01/82 04/30/82	M'Clure Strait, Prince of Wales Strait, Viscount Melville Sound, Barrow Strait	Sea water: Nitrogen-, Phosphorous-, Silica-based Nutrients	Water Column: CTD, S		
82-0120A	ARCTIC LABORATORIES LTD. Dept. of Indian Affairs and Northern Development	05/28/82 06/06/82	Strathcona Sound	Sea water: Nitrogen-, Phosphorous-, Silica-based Nutrients Sediments: Other	Water Column: S	Bottom sediment: sedimentation rate, water content, particle size	
82-0120B	ARCTIC LABORATORIES LTD. Dept. of Indian Affairs and Northern Development	08/17/82 08/18/82	Strathcona Sound	Biota: Other			
83-0010	ARCTIC SCIENCES LTD. Institute of Ocean Sciences	03/20/83 04/04/83	Prince Regent Inlet, Viscount Melville Sound, Barrow Strait, M'Clure Sound, Lancaster Sound	Sea water: Nitrogen-, Phosphorous-, Silica-based Nutrients	Water Column: CTD, S		
83-0078	OCEAN PHYSICS INSTITUTE OF OCEAN SCIENCES	03/01/83 04/30/83	Eastern Viscount Melville Sound, Barrow Strait	Sea water: Nitrogen-, Phosphorous-, Silica-based Nutrients			

DATA SET I.D.	COLLECTING AGENCY, SHIP: Sponsor	COLLECTING PERIOD	AREAS	CHEMICAL PARAMETERS MEASURED *OR SAMPLED*	CONCURRENT PHYSICAL MEASUREMENTS	CONCURRENT BIOLOGICAL MEASUREMENTS	REMARKS
83-0079	MARINE ECOLOGY LABORATORY CSS Hudson Bedford Institute of Oceanography	07/28/83 09/17/83	Lancaster Sound	Sea water: Pigments Nitrogen-, Phosphorous-, Silica-based Nutrients C-H-N-P Other			
85-0022	FRESHWATER INSTITUTE	05/28/85 06/19/86	Barrow Strait, Viscount Melville Sound	Biota: Pigments Sea water: Nitrogen-, Phosphorous-, Silica-based Nutrients	Snow: snow thickness	Biota: algal biomass, amphipod biomass	
OTHER	FRESHWATER INSTITUTE C.S.L. Ogac, Northern Oil and Gas Action Plan	03/01/84 09/30/84	Resolute Bay, Bathurst Island, Maxwell Bay	Water Column: C-H-N-P Nitrogen-, Phosphorous-, Silica-based Nutrients Other	Water Column: T,S	Biota: plankton	Data are incomplete and have not been verified.
	FRESHWATER INSTITUTE C.S.L. Ogac, Northern Oil and Gas Action Plan	03/01/85 09/30/85	Resolute Bay, Bathurst Island, Maxwell Bay	Water Column: C-H-N-P Nitrogen-, Phosphorous-, Silica-based Nutrients Other	Water Column: T,S	Biota: plankton	Data are incomplete and have not been verified.
	FRESHWATER INSTITUTE C.S.L. Ogac, Northern Oil and Gas Action Plan	03/01/86 09/30/86	Resolute Bay, Bathurst Island, Maxwell Bay	Water Column: C-H-N-P Nitrogen-, Phosphorous-, Silica-based Nutrients Other	Water Column: T,S	Biota: plankton	Data are incomplete and have not been verified.
	FRESHWATER INSTITUTE C.S.L. Ogac, Northern Oil and Gas Action Plan	04/01/87 09/30/87	Resolute Bay, Bathurst Island, Maxwell Bay	Water Column: C-H-N-P Nitrogen-, Phosphorous-, Silica-based Nutrients Other	Water Column: T,S	Biota: plankton	Data are incomplete and have not been verified.
	FRESHWATER INTITUTE C.S.L. Ogac, Northern Oil and Gas Action Plan	07/01/88 09/30/88	Resolute Bay, Bathurst Island, Maxwell Bay	Water Column: C-H-N-P Nitrogen-, Phosphorous-, Silica-based Nutrients Other	Water Column: T,S	Biota: plankton	Data are incomplete and have not been verified.
	FRESHWATER INSTITUTE C.S.L. Ogac, Northern Oil and Gas Action Plan	06/01/89 09/30/89	Resolute Bay, Bathurst Island, Maxwell Bay	Water Column: C-H-N-P Nitrogen-, Phosphorous-, Silica-based Nutrients Other	Water Column: T,S	Biota: plankton	Data are incomplete and have not been verified.

DATA SET I.D.	COLLECTING AGENCY, SHIP: Sponsor	COLLECTING PERIOD	AREAS	CHEMICAL PARAMETERS MEASURED OR SAMPLED	CONCURRENT PHYSICAL MEASUREMENTS	CONCURRENT BIOLOGICAL MEASUREMENTS	REMARKS
OTHER (cont'd)	FRESHWATER INSTITUTE C.S.L. Ogac, Northern Oil and Gas Action Plan	07/01/90 09/30/90	Resolute Bay, Bathurst Island, Maxwell Bay	Water Column: C-H-N-P Nitrogen-, Phosphorous-, Silica-based Nutrients Other	Water Column: T,S	Biota: plankton	Data are incomplete and have not been verified.

8. DATA INVENTORY TABLE 2

Use of NPG

where NPG (No Position Given) is used in the remarks column it appears only on the first line of the data set but applies to all parameters of the data set unless specifically indicated otherwise.

DATASET I.D.	MEDIUM SAMPLED	MEASUREMENT		NO. STATIONS	NO. SAMPLES	NO. SAMPLES >d.l.	METHODOLOGY INFORMATION					MEASURED VALUES			DATA RATING	REMARKS
		Qty	Units				Collection	Storage	Analysis	Precision	Accuracy	Range	Mean	Median		
79-0126	SEA WATER	CHL a	$mg.m^{-3}$	44	44	44	sfc (plastic bucket), depth (Niskin bottle)	filtered, frozen on glass fibre in a dessicator (-20°C)	Irwin et al. (1980)	NS	NS	0.25-10.96	2.72	1.30	2	
		NH_3	$mmol.m^{-3}$	44	42	42	sfc (plastic bucket), depth (Niskin bottle)	frozen (-20°C)	colorometric method (Solorzano, 1969)	NS	NS	0.05-7.28	1.65	0.53	2	
		NO_3	$mmol.m^{-3}$	44	44	44	sfc (plastic bucket), depth (Niskin bottle)	frozen (-20°C)	Technicon AuA method 158-71W	NS	NS	0.00-7.35	0.99	0.03	2	
		N	$mg.m^{-3}$	44	44	44	sfc (plastic bucket), depth (Niskin bottle)	filtered, frozen (-20°C)	Irwin et al. (1980)	NS	NS	6.00-51	23.00	14.50	2	
		PO_4	$mmol.m^{-3}$	44	44	44	sfc (plastic bucket), depth (Niskin bottle)	frozen (-20°C)	Technicon AuA method 155-71W	NS	NS	0.09-3.26	0.56	0.25	2	
		SiO_3	$mmol.m^{-3}$	44	44	44	sfc (plastic bucket), depth (Niskin bottle)	frozen (-20°C)	Technicon AuA method 186-72W	NS	NS	0.69-21.18	6.36	2.23	2	
		Part-C	$mg.m^{-3}$	44	44	44	sfc (plastic bucket), depth (Niskin bottle)	filtered, frozen (-20°C)	Irwin et al. (1980)	NS	NS	36.00-409.00	150.86	88.50	2	
		ATP	$mg.m^{-3}$	44	43	43	sfc (plastic bucket), depth (Niskin bottle)	3 min. extraction in tris buffer, frozen (-20°C)	Irwin et al. (1980)	NS	NS	0.08-1.29	0.57	0.57	2	
		DNA	$mg.m^{-3}$	44	41	41	sfc (plastic bucket), depth (Niskin bottle)	filtered, frozen (-20°C)	Irwin et al. (1980)	NS	NS	0.18-9.10	4.84	4.98	2	
		Protein	$mg.m^{-3}$	44	44	44	sfc (plastic bucket), depth (Niskin bottle)	filtered, frozen (-20°C)	Irwin et al. (1980)	NS	NS	24.90-285.40	109.17	64.25	2	
		RNA	$mg.m^{-3}$	44	41	41	sfc (plastic bucket), depth (Niskin bottle)	filtered, frozen (-20°C)	Irwin et al. (1980)	NS	NS	1.11-32.04	12.90	13.75	2	
80-0115	SEA WATER	CHL a	$mg.m^{-3}$	7	25	25	sfc (plastic bucket), depth (Niskin bottle)	5.5 cm Whatman GF/C glass fibre filters, placed in vials containing acetone	fluorometric technique, Holm-Hansen et al. (1965)	NS	NS	0.62-15.02	3.82	3.22	2	
		NH_3	$mmol.m^{-3}$	7	25	25	sfc (plastic bucket), depth (Niskin bottle)	frozen (-20°C) method (Solorzano, 1969)	phenolhypochlorite	NS	NS	0.00-0.55	0.31	0.26	2	

DATASET I.D.	MEDIUM SAMPLED	MEASUREMENT		NO. STATIONS	NO. SAMPLES	NO. SAMPLES >d.l.	METHODOLOGY INFORMATION					MEASURED VALUES			DATA RATING	REMARKS
		Qty	Units				Collection	Storage	Analysis	Precision	Accuracy	Range	Mean	Median		
80-0115 (cont'd)		NO_3	$mmol.m^3$	7	25	25	sfc (plastic bucket), depth (Niskin bottle)	frozen (-20°C)	Technicon AuA method 158-71W	NS	NS	0.00-11.36	2.09	0.83	2	
		Part-N	$mg.m^3$	7	21	21	sfc (plastic bucket), depth (Niskin bottle)	filtered, frozen (-20°C)	Irwin et al. (1982)	NS	NS	7.00-40.00	17.71	14.00	2	
		PO_4	$mmol.m^3$	7	25	25	sfc (plastic bucket), depth (Niskin bottle)	frozen (-20°C)	Technicon AuA method 155-71W	NS	NS	0.53-1.55	0.92	0.86	2	
		SiO_3	$mmol.m^3$	7	25	25	sfc (plastic bucket), depth (Niskin bottle)	frozen (-20°C)	Technicon AuA method 186-72W	NS	NS	1.42-22.89	7.26	6.33	2	
		Urea	$mmol.m^3$	7	25	25	sfc (plastic bucket), depth (Niskin bottle)	frozen (-20°C)	urease method (McCarthy, 1970)	NS	NS	0.00-0.89	0.39	0.37	2	
		Part-C	$mg.m^3$	7	24	24	sfc (plastic bucket), depth (Niskin bottle)	filtered, frozen (-20°C)	Irwin et al. (1982)	NS	NS	25.00-308.00	161.71	85.50	2	
		ATP	$mg.m^3$	7	24	24	sfc (plastic bucket), depth (Niskin bottle)	filtered, frozen (-20°C)	Irwin et al. (1982)	NS	NS	0.71-5.45	1.95	1.11	2	
		DNA	$mg.m^3$	7	25	25	sfc (plastic bucket), depth (Niskin bottle)	filtered, frozen (-20°C)	Irwin et al. (1982)	NS	NS	0.44-4.02	2.02	1.76	2	
		Protein	$mg.m^3$	7	25	25	sfc (plastic bucket), depth (Niskin bottle)	filtered, frozen (-20°C)	Irwin et al. (1982)	NS	NS	42.30-699.90	236.01	221.40	2	
		RNA	$mg.m^3$	7	25	25	sfc (plastic bucket), depth (Niskin bottle)	filtered, frozen (-20°C)	Irwin et al. (1982)	NS	NS	2.52-22.08	8.99	9.14	2	
82-0003	SEA WATER	NO_3	$mmol.m^3$	12	73	73	Knudsen bottle	frozen in glass vials	Technicon AuA	NS	NS	3.1-19.7	8.9	8.7	2	
		PO_4	$mmol.m^3$	12	62	62	Knudsen bottle	frozen in plastic vials	Technicon AuA	NS	NS	0.9-3.8	1.4	1.1	2	
		SiO_3	$mmol.m^3$	12	72	72	Knudsen bottle	frozen in plastic vials	Technicon AuA	NS	NS	6.0-19.2	19.2	12.3	2	
82-0004	SEA WATER	NO_3	$mmol.m^3$	6	7	7	Knudsen bottle	filtered onto 25 mm GF/F filters, stored in dark place		NS	NS	3.7-14.9	8.7	8.1	2	

DATASET I.D.	MEDIUM SAMPLED	MEASUREMENT		NO. STATIONS	NO. SAMPLES	NO. SAMPLES >d.l.	METHODOLOGY INFORMATION					MEASURED VALUES			DATA RATING	REMARKS
		Qty	Units				Collection	Storage	Analysis	Precision	Accuracy	Range	Mean	Median		
82-0004 (cont'd)		PO_4	$mmol.m^{-3}$	6	7	7	Knudsen bottle	frozen in acrylic core liners for approx. 4 months		NS	NS	1.3-2.8	2.0	2.2	2	
		SiO_3	$mmol.m^{-3}$	6	7	7	Knudsen bottle	frozen in acrylic core liners for approx. 4 months		NS	NS	9.6-31.5	19.5	14.3	2	
82-0120A	SEA WATER	Cd	$\mu mol.m^{-3}$	10	111	111	acid cleaned GO-FLO bottles	acid cleaned CPE bottles	modified Danielsson et al. (1978)	6.3% at at 0.41 $\mu mol.m^{-3}$	-17%	0.21-1.17	0.38	0.36	4	
		Fe	$\mu mol.m^{-3}$	10	115	115	acid cleaned GO-FLO bottles	acid cleaned CPE bottles	modified Danielsson et al. (1978)	15% at at 10 $\mu mol.m^{-3}$	-46%, 24%	2.00-1287	49.99	22.60	4	
		Pb	$\mu mol.m^{-3}$	10	115	115	acid cleaned GO-FLO bottles	acid cleaned CPE bottles	modified Danielsson et al. (1978)	30% at 0.14 $\mu mol.m^{-3}$	-42% -24%	0.01-38.20	1.09	0.14	4	
		Zn	$\mu mol.m^{-3}$	10	114	114	acid cleaned GO-FLO bottles	acid cleaned CPE bottles	modified Danielsson et al. (1978)	17% at 6.0 $\mu mol.m^{-3}$	-4%, +5%	0.40-351.00	13.26	1.70	4	
		NO_3	$mmol.m^{-3}$	4	37	37	acid cleaned GO-FLO bottles	frozen	Macdonald and McLaughlin (1982)	±0.4%	±4%	7.60-15.00	10.36	9.80	4	
		PO_4	$mmol.m^{-3}$	4	37	37	acid cleaned GO-FLO bottles	frozen	Macdonald and McLaughlin (1982)	±0.3%	±5%	1.05-1.53	1.33	1.33	4	
		SiO_3	$mmol.m^{-3}$	4	37	37	acid cleaned GO-FLO bottles	frozen	Macdonald and McLaughlin (1982)	±0.3%	±5%	15.70-30.90	20.54	18.90	4	
	SEDIMENTS	Cd	$\mu mol.kg^{-1}$	26	152	152	gravity corer	frozen in Whirlpak bags	aqua regia Teflon bomb digestion, GFAAS	±13.3%, ±17.2%, ±13.1%	-8.6%, -9.9% -1.1%	0.84-46.62	4.20	1.70	4	DWB
		Pb	$\mu mol.kg^{-1}$	26	152	152	gravity corer	frozen in Whirlpak bags	aqua regia Teflon bomb digestion, GFAAS	±12.4%, ±6.3%, ±28.6%	-29%, -37%, -33%	43.00-632.00	135.03	76.50	4	DWB
		Zn	$mmol.kg^{-1}$	26	152	152	gravity corer	frozen in Whirlpak bags	aqua regia Teflon bomb digestion, FAAS	±2.9%, ±4.7%, ±2.3%, ±6.3%	-4.9%, -7.7%, -2.0%, -2.4%	0.59-25.09	2.25	0.99	4	DWB
		Particle size	% finer than 38µm	2	2	2	gravity corer	frozen in Whirlpak bags	sieved through nest (2000µm, 850µm, 425µm, 250µm, 100µm, 75µm, 38µm) of standard screens	±1-6%	NS	22.8-36.6	29.7	29.7	3	DWB

DATASET I.D.	MEDIUM SAMPLED	MEASUREMENT		NO. STATIONS	NO. SAMPLES	NO. SAMPLES >d.l.	METHODOLOGY INFORMATION					MEASURED VALUES			DATA RATING	REMARKS
		Qty	Units				Collection	Storage	Analysis	Precision	Accuracy	Range	Mean	Median		
82-0120B	BIOTA (Bivalves: Mya truncata)	Cd	$\mu g.g^{-1}$	6	28	28	by diver	24 h depuration, frozen	dried, pulverised, digested with 10 mL "Aristar" nitric acid, AAS	±12	-8.6%	0.20-7.20	3.03	1.55	4	DWB
		Pb	$\mu g.g^{-1}$	6	28	28	by diver	24 h depuration, frozen	dried, pulverised, digested with 10 mL "Aristar" nitric acid, AAS	±8	-14.6%, +13%	0.30 10.50	3.02	1.17	4	DWB
		Zn	$\mu g.g^{-1}$	6	28	28	by diver	24 h depuration, frozen	dried, pulverised, digested with 10 mL "Aristar" nitric acid, AAS	±9	-1.4%, -5%	135.00-850.00	395.50	248.00	4	DWB
		Glycogen	%	6	36	36	by diver	24 h depuration, frozen	Dubois et al. (1956)	NS	NS	3.000-20.200	9.060	5.85	2	
		Lipids	%	6	36	36	by diver	24 h depuration, frozen	Bligh and Dyer (1959)	NS	NS	3.000-20.200	9.060	5.85	2	
		Protein	%	6	36	36	by diver	24 h depuration, frozen	Lowry et al. (1951)	NS	NS	20.500-45.200	30.350	25.65	2	
83-0010	SEA WATER	NO_3	$mmol.m^{-3}$	11	39	39	Knudsen bottle	frozen in glass vials	Technicon AuA	NS	NS	0.4-20.2	12.0	13.1	2	
		PO_4	$mmol.m^{-3}$	11	39	39	Knudsen bottle	frozen in plastic vials	Technicon AuA	NS	NS	0.1-2.0	1.5	1.5	2	
		SiO_3	$mmol.m^{-3}$	11	39	39	Knudsen bottle	frozen in plastic vials	Technicon AuA	NS	NS	4.8-38.2	23.7	25.8	2	
83-0078	SEA WATER	NO_3	$mmol.m^{-3}$	4	8	8	Knudsen bottle	frozen in glass vials	Technicon AuA	NS	NS	1.1-10.7	10.7	7.5	2	
		PO_4	$mmol.m^{-3}$	4	8	8	Knudsen bottle	frozen in plastic vials	Technicon AuA	NS	NS	1.6-3.0	2.3	2.1	2	
		SiO_3	$mmol.m^{-3}$	4	8	8	Knudsen bottle	frozen in plastic vials	Technicon AuA	NS	NS	6.6-37.4	23.2	18.4	2	
83-0079	SEA WATER	CHL a	$mg.m^{-3}$	6	40	40	modified continuous pump sampler, Herman et al. (1984)	filtered onto 25 mm GF/F filters, stored in dark place	shipboard fluorometric - Yentsch and Menzel (1963)	NS	NS	0.05-5.03	1.02	0.31	2	
		NO_3	$mmol.m^{-3}$	6	39	39	modified continuous pump sampler, Herman et al. (1984)	in glass vials	shipboard Technicon II AuA method 158-71W	NS	NS	0.00-22.01	7.31	8.53	2	

DATASET I.D.	MEDIUM SAMPLED	MEASUREMENT		NO. STAT-IONS	NO. SAM-PLES	NO. SAM-PLES >d.l.	METHODOLOGY INFORMATION					MEASURED VALUES			DATA RATING	REMARKS
		Qty	Units				Collection	Storage	Analysis	Precision	Accuracy	Range	Mean	Median		
83-0079 (cont'd)		PO_4	$mmol.m^3$	6	42	42	modified continuous pump sampler, Herman et al. (1984)	in plastic vials	shipboard Technicon AuA method 155-71W	NS	NS	0.47-3.22	1.56	1.07	2	
		SiO_3	$mmol.m^3$	6	39	39	modified continuous pump sampler, Herman et al. (1984)	in plastic vials	shipboard Technicon II AuA method 186-72W	NS	NS	0.13-46.66	15.88	13.50	2	
		C	$mg.m^3$	6	40	40	modified continuous pump sampler, Herman et al. (1984)	Whatman GF/F glass fibre filters or 1.0 µm Nucleopore filters	Irwin et al. (1982)	NS	NS	51.00-797.00	161.38	88.00	2	
		N	$mg.m^3$	6	31	31	modified continuous pump sampler, Herman et al. (1984)	Whatman GF/F glass fibre filters or 1.0 µm Nucleopore filters	Irwin et al. (1982)	NS	NS	12.00-116.00	37.14	29.00	2	
		ATP	$mg.m^3$	6	39	39	modified continuous pump sampler, Herman et al. (1984)	Whatman GF/F glass fibre filters or 1.0 µm Nucleopore filters	Irwin et al. (1982)	NS	NS	0.03-.034	0.11	0.10	2	
85-0022	BIOTA (ice algae)	CHL a	$mg.m^3$	9	7	7	frozen in glass at -30°C to -40°C	kept cold and dark, filtered through Whatman GF/C filters	fluorometric - Turner model III	NS	NS	44-360	157	112	2	NPG
	SEA WATER	SiO_3	$g.m^3$	9	7	7	7.3 cm diameter SIPRE corer, Licor 185, SSC	kept cold and dark, filtered through Whatman GF/C filters	Stainton et al. (1977) - Technicon autoanalyser	NS	NS	0.6-4.7	2.0	1.5	2	

9. DATA INVENTORY TABLE 3

DATA SET I.D.	STATION NUMBER	LATITUDE °N	LONGITUDE °W	STATION DEPTH (m)	TIME SAMPLED YEAR	MONTH	DAY	HOUR GMT	NUMBER POINTS	MAXIMUM DEPTH SAMPLED (m)
79-0126	10	73° 45.3'	83° 55.8'	sfc	1979	07	21	NS	1	sfc
	11	73° 38.3'	83° 54.8'	sfc	1979	07	22	NS	1	sfc
	12	73° 38.3'	83° 53.8'	sfc	1979	07	22	NS	1	sfc
	13	73° 37.0'	83° 55.3'	sfc	1979	07	23	NS	1	sfc
	14	73° 33.5'	84° 3.0'	sfc	1979	07	24	NS	1	sfc
	15	73° 29.0'	83° 18.0'	sfc	1979	07	24	NS	1	sfc
	17	73° 16.5'	85° 16.0'	sfc	1979	07	28	NS	1	sfc
	18	73° 4.4'	84° 26.2'	sfc	1979	07	29	NS	1	sfc
	19	73° 41.5'	83° 36.0'	sfc	1979	07	30	NS	1	sfc
	20	73° 41.5'	83° 36.0'	sfc	1979	07	31	NS	1	sfc
	21	73° 43.4'	83° 42.2'	sfc	1979	08	01	NS	1	sfc
	22	73° 36.0'	83° 54.0'	sfc	1979	08	02	NS	1	sfc
	23	73° 43.0'	83° 32.0'	sfc	1979	08	03	NS	1	sfc
	24	74° 32.3'	82° 26.9'	sfc	1979	08	04	NS	1	sfc
	25	74° 32.3'	82° 26.9'	sfc	1979	08	05	NS	1	sfc
	28	75° 35.7'	83° 57.0'	10	1979	08	08	NS	1	10
	29	73° 19.6'	85° 25.1'	10	1979	08	09	NS	1	10
	38	74° 31.9'	82° 27.3'	10	1979	08	17	NS	1	10
	39	74° 31.9'	82° 27.3'	10	1979	08	18	NS	1	10
	40	74° 31.8'	82° 27.6'	10	1979	08	19	NS	1	10
	41	74° 31.8'	82° 27.6'	10	1979	08	20	NS	1	10
	42	74° 31.8'	82° 27.6'	10	1979	08	21	NS	1	10
	43	74° 31.8'	82° 27.6'	10	1979	08	22	NS	1	10
	44	74° 31.8'	82° 27.6'	10	1979	08	23	NS	1	10
	52	73° 41.5'	83° 26.8'	sfc	1979	09	01	NS	1	10
	58	74° 32.3'	83° 27.0'	10	1979	09	07	NS	1	10
	59	74° 32.3'	83° 27.0'	10	1979	09	07	NS	1	10
	60	74° 32.3'	82° 27.0'	10	1979	09	08	NS	1	10
	61	74° 32.3'	82° 27.0'	10	1979	09	08	NS	1	10
	62	74° 32.3'	82° 27.0'	10	1979	09	09	NS	1	10
	63	74° 32.3'	82° 27.0'	10	1979	09	09	NS	1	10
	64	74° 32.3'	82° 27.0'	10	1979	09	10	NS	1	10
	65	74° 34.8'	83° 11.0'	10	1979	09	11	NS	1	10
	67	74° 27.0'	83° 5.0'	10	1979	09	13	NS	1	10
	69	74° 35.5'	83° 11.5'	10	1979	09	14	NS	1	10
	74	74° 39.1'	94° 45.0'	10	1979	09	18	NS	1	10
	75	73° 4.9'	84° 34.3'	10	1979	09	19	NS	1	10
	77	73° 40.4'	80° 52.0'	10	1979	09	20	NS	1	10
	79	73° 40.4'	80° 52.0'	10	1979	09	22	NS	1	10
	80	73° 40.4'	80° 52.0'	10	1979	09	22	NS	1	10
	82	73° 40.4'	80° 52.0'	10	1979	09	23	NS	1	10
	83	73° 40.4'	80° 52.0'	10	1979	09	24	NS	1	10
	92	73° 4.5'	84° 28.9'	10	1979	09	27	NS	1	10
	94	74° 30.3'	92° 46.0'	sfc	1979	09	29	NS	1	sfc

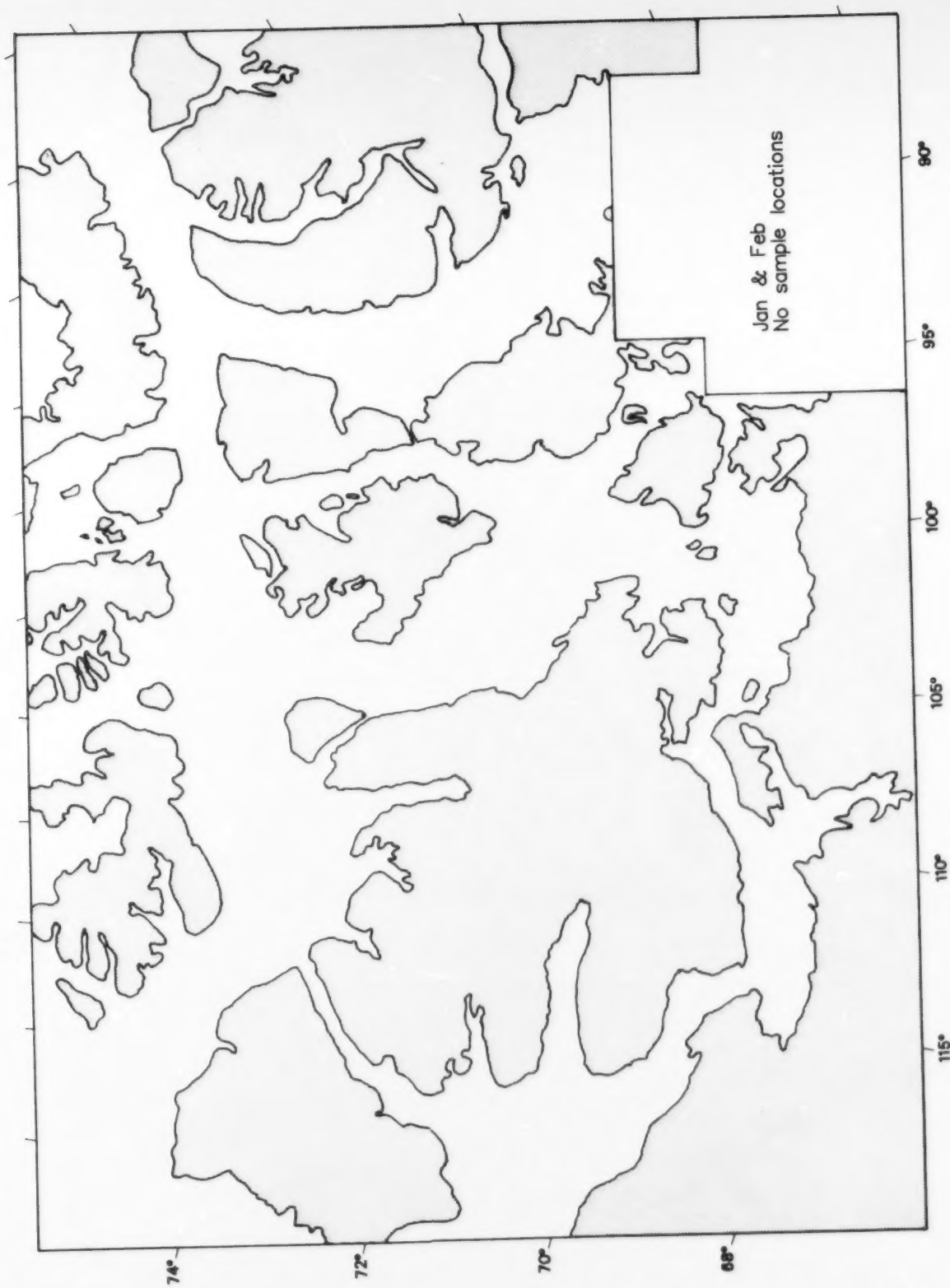
DATA SET I.D.	STATION NUMBER	LATITUDE °N	LONGITUDE °W	STATION DEPTH (m)	TIME SAMPLED YEAR	MONTH	DAY	HOUR GMT	NUMBER POINTS	MAXIMUM DEPTH SAMPLED (m)
80-0115	100	74° 26.30'	86° 3.00'	5	1980	08	06	NS	1	5
	101	74° 26.30'	86° 3.00'	24	1980	08	06	NS	1	24
	102	74° 26.30'	86° 3.00'	60	1980	08	06	NS	1	60
	103	73° 48.30'	81° 5.50'	40	1980	08	12	NS	1	40
	104	73° 48.30'	81° 5.50'	40	1980	08	12	NS	1	40
	105	73° 48.30'	81° 5.50'	40	1980	08	12	NS	1	40
	106	73° 48.30'	81° 5.50'	40	1980	08	12	NS	1	40
	107	74° 37.90'	93° 39.00'	5	1980	08	13	NS	1	5
	108	74° 37.90'	93° 39.00'	10	1980	08	13	NS	1	10
	109	74° 37.90'	93° 39.00'	25	1980	08	13	NS	1	25
	110	74° 28.70'	92° 2.30'	29	1980	08	14	NS	1	29
	111	74° 28.70'	92° 2.30'	29	1980	08	14	NS	1	29
	112	74° 28.70'	92° 2.30'	29	1980	08	14	NS	1	29
	113	74° 28.70'	92° 2.30'	29	1980	08	14	NS	1	29
	114	73° 37.60'	89° 44.00'	10	1980	08	15	NS	1	10
	115	73° 37.60'	89° 44.00'	20	1980	08	15	NS	1	20
	116	73° 37.60'	89° 44.00'	40	1980	08	15	NS	1	40
	117	73° 5.00'	84° 32.30'	5	1980	08	18	NS	1	5
	118	73° 5.00'	84° 32.30'	5	1980	08	18	NS	1	5
	119	73° 5.00'	84° 32.30'	5	1980	08	18	NS	1	5
	120	73° 5.00'	84° 32.30'	5	1980	08	18	NS	1	5
	121	74° 12.80'	81° 46.00'	11	1980	08	19	NS	1	11
	122	74° 12.80'	81° 46.00'	11	1980	08	19	NS	1	11
	123	74° 12.80'	81° 46.00'	11	1980	08	19	NS	1	11
	124	74° 12.80'	81° 46.00'	11	1980	08	19	NS	1	11
82-0003	E1(4123)	75° 33.08'	119° 23.58'	272	1982	03	26	1742	2	346
	E2(4124)	75° 24.20'	119° 45.40'	5	1982	03	26	1859	2	415
	E2(4124)	75° 24.20'	119° 45.40'	50	1982	03	26	1859	2	415
	E5(4126)	74° 48.68'	121° 6.30'	5	1982	03	26	2130	2	525
	E5(4126)	74° 48.68'	121° 6.30'	50	1982	03	26	2130	2	525
	F1	71° 35.08'	119° 25.20'	36	1982	04	02	2002	2	108
	F1	71° 35.08'	119° 25.20'	75	1982	04	02	2002	2	108
	F1(4152)	71° 35.08'	119° 25.20'	5	1982	04	02	2002	2	108
	F4	71° 33.40'	120° 17.20'	75	1982	04	02	1735	2	95
	F4(4150)	71° 33.40'	120° 17.20'	5	1982	04	02	1735	2	95
	K2	71° 6.60'	99° 58.08'	75	1982	04	06	1823	2	98
	K2(4169)	71° 6.60'	99° 58.08'	5	1982	04	06	1823	2	98
	L2	73° 11.00'	90° 50.40'	75	1982	04	05	2114	2	309
	L2	73° 11.00'	90° 50.40'	225	1982	04	05	2114	2	309
	L2(4166)	73° 11.00'	90° 50.40'	5	1982	04	05	2114	2	309
	L5	73° 5.30'	89° 43.40'	225	1982	04	05	1852	2	381
	L5	73° 5.30'	89° 43.40'	75	1982	04	05	1852	2	381
	L5(4163)	73° 5.30'	89° 43.40'	5	1982	04	05	1852	2	381
	M2	72° 58.00'	104° 28.08'	147	1982	04	04	1807	2	177

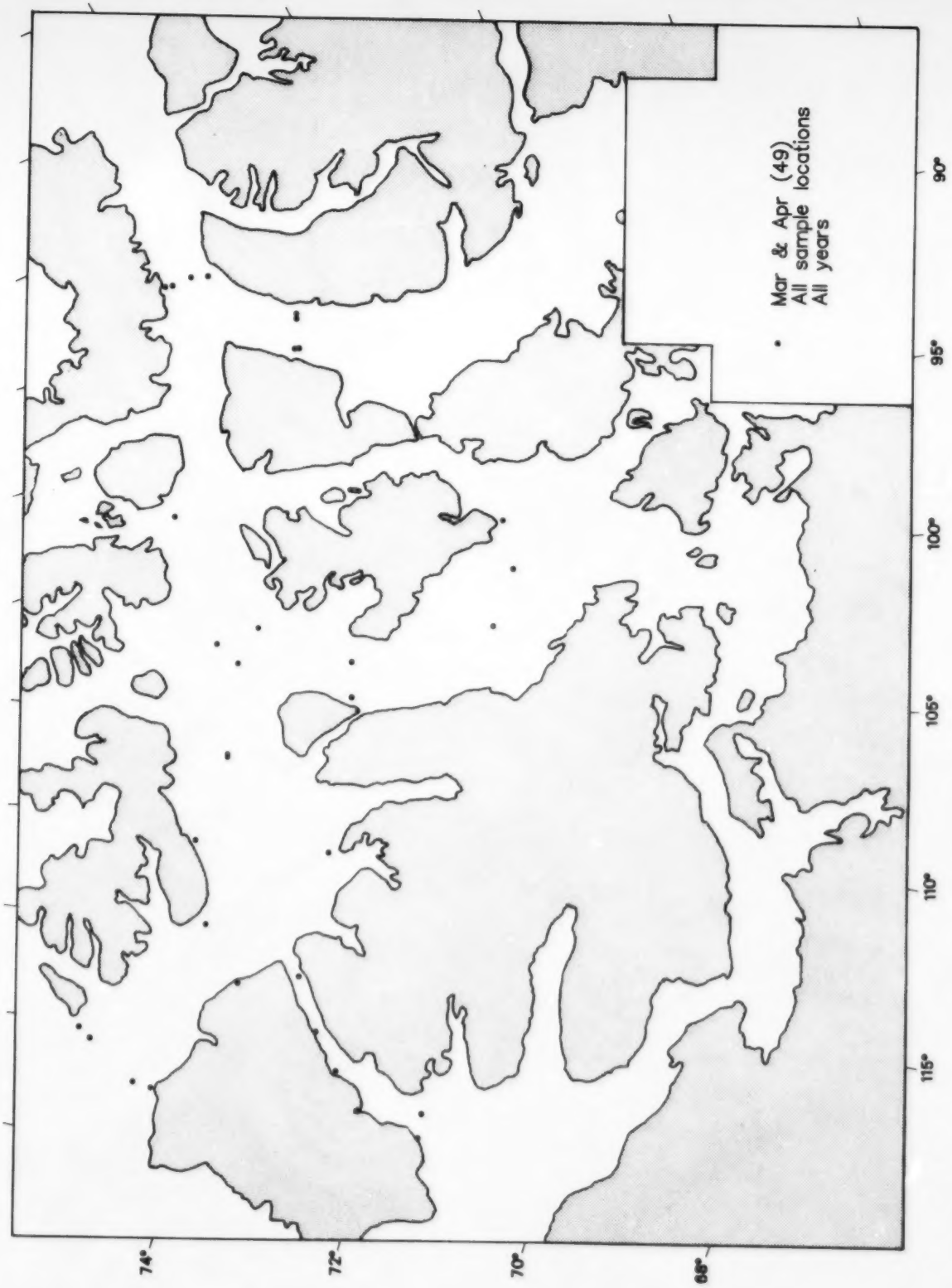
DATA SET I.D.	STATION NUMBER	LATITUDE °N	LONGITUDE °W	STATION DEPTH (m)	TIME SAMPLED YEAR	MONTH	DAY	HOUR GMT	NUMBER POINTS	MAXIMUM DEPTH SAMPLED (m)
82-0003 (cont'd)	M2	72° 58.00'	104° 28.08'	75	1982	04	04	1807	2	177
	M2(4155)	72° 58.00'	104° 28.08'	5	1982	04	04	1807	2	177
	M5	72° 57.80'	103° 6.88'	75	1982	04	04	2041	2	289
	M5	72° 57.80'	103° 6.88'	234	1982	04	04	2041	2	289
	M5(4158)	72° 57.80'	103° 6.88'	5	1982	04	04	2041	2	289
	N2	74° 20.20'	87° 12.28'	50	1982	03	21	1830	2	415
	N2(4103)	74° 20.20'	87° 12.28'	5	1982	03	21	1830	2	415
	N5	73° 55.58'	87° 13.60'	50	1982	03	21	2122	2	440
	N5(4106)	73° 55.58'	87° 13.60'	5	1982	03	21	2122	2	440
82-0004	14(4327)	72° 57.3'	117° 22.0'	179	1982	04	01	1611	2	179
	21(4353)	73° 16.1'	115° 24.2'	60	1982	04	04	2351	1	60
	36A(4356)	73° 8.0'	110° 28.5'	130	1982	04	05	2102	1	130
	43(4362)	74° 37.8'	110° 31.2'	111.1	1982	04	15	2144	1	111.1
	T2(4338)	72° 38.2'	118° 39.6'	131	1982	04	03	1543	1	131
	T2(4339)	72° 38.2'	118° 39.6'	131	1982	04	03	1616	1	131
82-0120A	1	73° 4.2'	84° 32.7'	48	1982	06	01	NS	1	bottom
	1	73° 4.2'	84° 32.7'	66	1982	06	05	NS	4	63
	10	73° 5.3'	84° 27.8'	166	1982	06	04	NS	5	163
	10	73° 5.3'	84° 27.8'	166	1982	06	04	NS	1	bottom
	11	73° 4.1'	84° 18.2'	36	1982	06	01	NS	1	bottom
	11	73° 4.1'	84° 18.2'	36	1982	06	04	NS	3	34
	12	73° 3.4'	84° 18.4'	36	1982	06	01	NS	1	bottom
	13	73° 4.0'	84° 26.1'	47	1982	06	02	NS	1	bottom
	14	73° 4.7'	84° 29.9'	124	1982	06	06	NS	1	bottom
	18	73° 4.1'	84° 28.8'	54	1982	06	02	NS	1	bottom
	19	73° 4.2'	84° 30.7'	43	1982	06	01	NS	1	bottom
	2	73° 4.5'	84° 32.5'	113	1982	05	28	NS	1	bottom
	20	73° 4.2'	84° 31.7'	65	1982	05	28	NS	1	bottom
	21	73° 4.5'	84° 31.5'	111	1982	05	28	NS	1	bottom
	22	73° 4.5'	84° 33.4'	112	1982	05	28	NS	1	bottom
	23	73° 4.3'	84° 33.6'	97	1982	05	29	NS	1	bottom
	24	73° 4.3'	84° 34.4'	58	1982	05	31	NS	1	bottom
	25	73° 4.9'	84° 33.9'	111	1982	05	30	NS	1	bottom
	26	73° 5.0'	84° 35.9'	126	1982	05	30	NS	1	bottom
	27	73° 4.4'	84° 36.3'	85	1982	05	30	NS	1	bottom
	28	73° 4.7'	84° 40.1'	104	1982	05	30	NS	1	bottom
	29	73° 5.0'	84° 40.0'	256	1982	05	30	NS	1	bottom
	3	73° 4.8'	84° 32.2'	116	1982	06	02	NS	1	bottom
	3	73° 4.8'	84° 32.2'	114	1982	06	04	NS	4	110
	30	73° 5.6'	84° 41.3'	273	1982	05	29	NS	1	bottom
	31	73° 5.7'	84° 46.3'	293	1982	05	29	NS	1	bottom
	4	73° 5.1'	84° 31.9'	114	1982	06	06	NS	1	bottom
	5	73° 5.6'	84° 31.5'	208	1982	06	02	NS	6	200

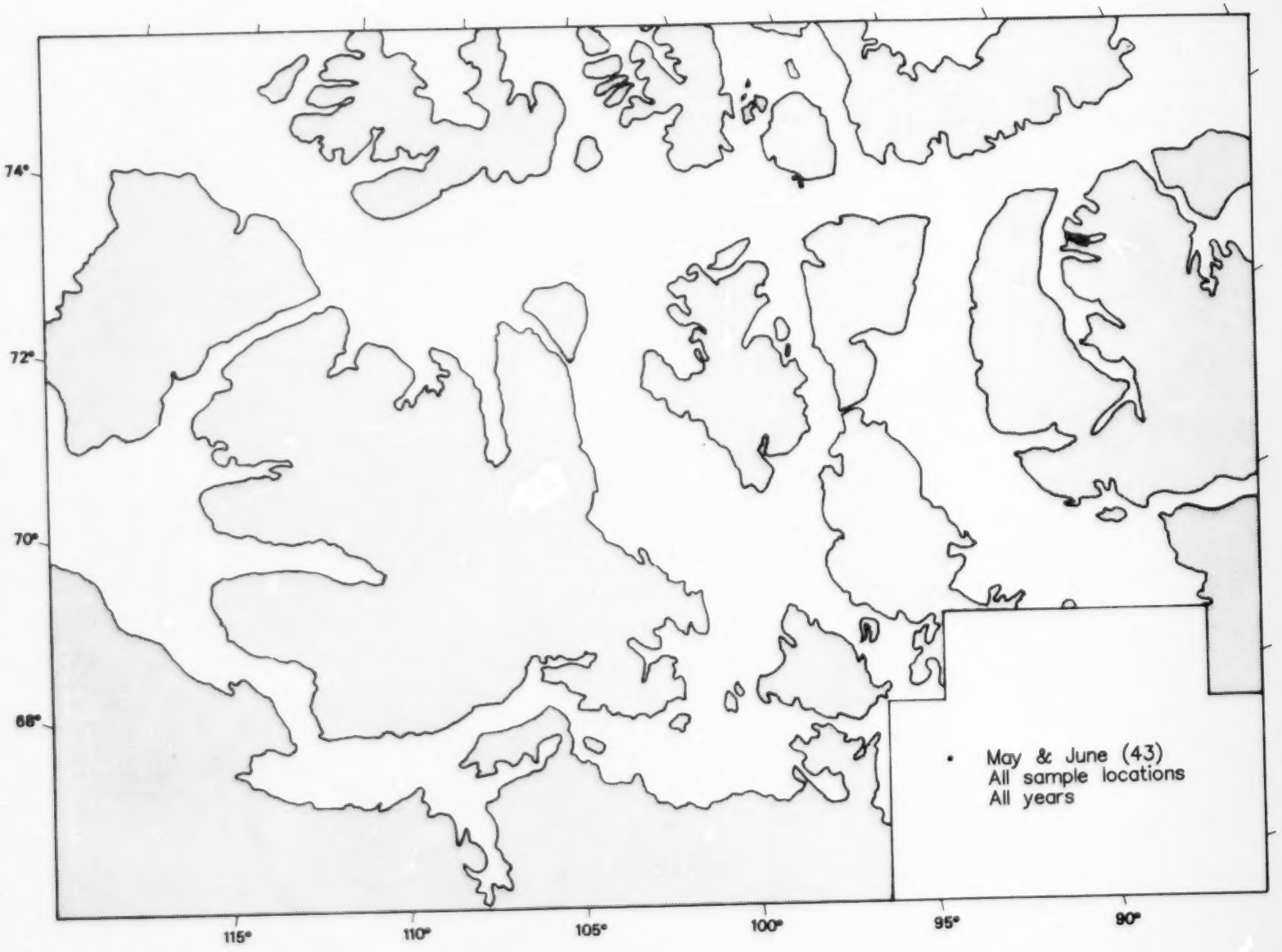
DATA SET I.D.	STATION NUMBER	LATITUDE °N	LONGITUDE °W	STATION DEPTH (m)	TIME SAMPLED YEAR	MONTH	DAY	HOUR GMT	NUMBER POINTS	MAXIMUM DEPTH SAMPLED (m)
82-0120A (cont'd)	5	73° 5.6'	84° 31.5'	210	1982	06	04	NS	1	bottom
	6	73° 6.5'	84° 30.4'	146	1982	06	03	NS	5	140
	6	73° 6.5'	84° 30.4'	136	1982	06	04	NS	1	bottom
	7	73° 7.3'	84° 51.0'	250	1982	06	06	NS	1	bottom
	8	73° 5.25'	84° 32.05'	250	1982	06	05	NS	6	247
	9	73° 6.0'	84° 35.3'	246	1982	06	04	NS	6	243
	9-1	73° 6.0'	84° 35.3'	246	1982	06	04	NS	1	bottom
	9-2	73° 6.0'	84° 35.3'	246	1982	06	04	NS	1	bottom
82-0120B	DS-1	73° 6.9'	84° 30.4'	8	1982	08	17	NS	1	bottom
	DS-2	73° 3.8'	84° 25.6'	7	1982	08	17	NS	1	bottom
	DS-3	73° 4.2'	84° 32.4'	10	1982	08	18	NS	1	bottom
	DS-4	73° 4.7'	84° 40.3'	9	1982	08	18	NS	1	bottom
	DS-5	73° 4.2'	84° 33.3'	10	1982	08	18	NS	1	bottom
	DS-6	73° 1.7'	85° 9.0'	3	1982	08	18	NS	1	bottom
83-0010	089(4801)	74° 49.68'	96° 45.60'	222	1983	03	21	2044	4	222
	E06(4819)	74° 36.00'	121° 8.70'	478	1983	03	26	2305	4	478
	K03(4805)	71° 10.60'	98° 15.38'	156	1983	03	23	NS	4	156
	K05(4804)	71° 21.90'	101° 56.08'	201	1983	03	22	2219	4	201
	L02(4825)	73° 8.00'	90° 51.58'	329	1983	03	28	1559	4	329
	L06(4837)	73° 4.60'	89° 32.00'	294	1983	03	30	1841	4	294
	N01(4827)	74° 25.00'	87° 10.50'	338	1983	03	28	1916	4	338
	N07/N08?(4829)	74° 6.68'	87° 5.10'	417	1983	03	28	2326	4	417
	O48(4806)	74° 20.50'	106° 56.40'	436	1983	03	23	1844	4	436
	R11(4814)	73° 55.60'	116° 6.50'	493	1983	03	25	2008	4	493
	R16(4812)	74° 23.60'	113° 58.00'	401	1983	03	25	1711	4	401
83-0078	48(4730)	74° 20.6'	106° 51.8'	404	1983	03	30	2247	2	404
	76(4707)	74° 28.0'	102° 15.0'	175	1983	03	24	1812	1	175
	77(4701)	74° 14.2'	103° 4.8'	267	1983	03	22	1856	2	267
	79(4704)	74° 0.0'	101° 39.5'	134	1983	03	23	1803	1	134
83-0079		74° 7.00'	81° 54.00'	25	1983	08	23	NS	1	25
		74° 21.10'	81° 49.80'	100	1983	08	24	NS	1	100
		73° 52.90'	81° 46.50'	100	1983	08	25	NS	1	100
		74° 22.00'	82° 32.50'	100	1983	08	26	NS	1	100
85-0022	Site 2	74° 39.02'	94° 56.04'	NS	1985	05	28	NS	1	NS
	Site 2	74° 39.02'	94° 56.04'	NS	1986	06	19	NS	1	NS
	Site 5	74° 35.23'	94° 50.19'	NS	1986	05	20	NS	1	NS
	Site 6	74° 32.92'	94° 49.99'	NS	1985	05	28	NS	1	NS
	Site 6	74° 32.92'	94° 49.99'	NS	1986	05	20	NS	1	NS
	South of Cape Martyr	74° 39.03'	95° 3.83'	NS	1985	05	28	NS	1	NS
	South of Cape Martyr	74° 39.03'	95° 3.83'	NS	1986	05	28	NS	1	NS

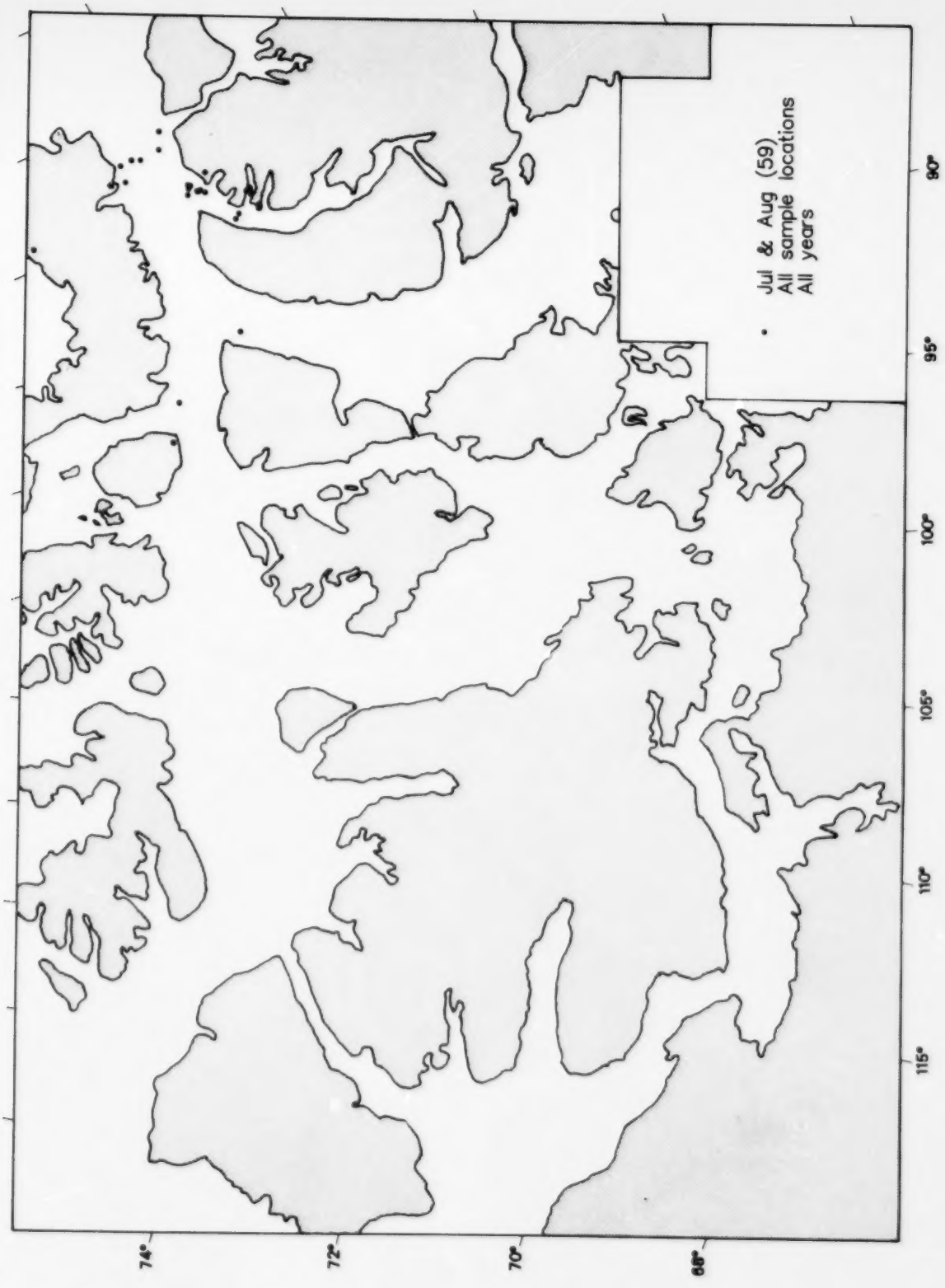
10. MAPS

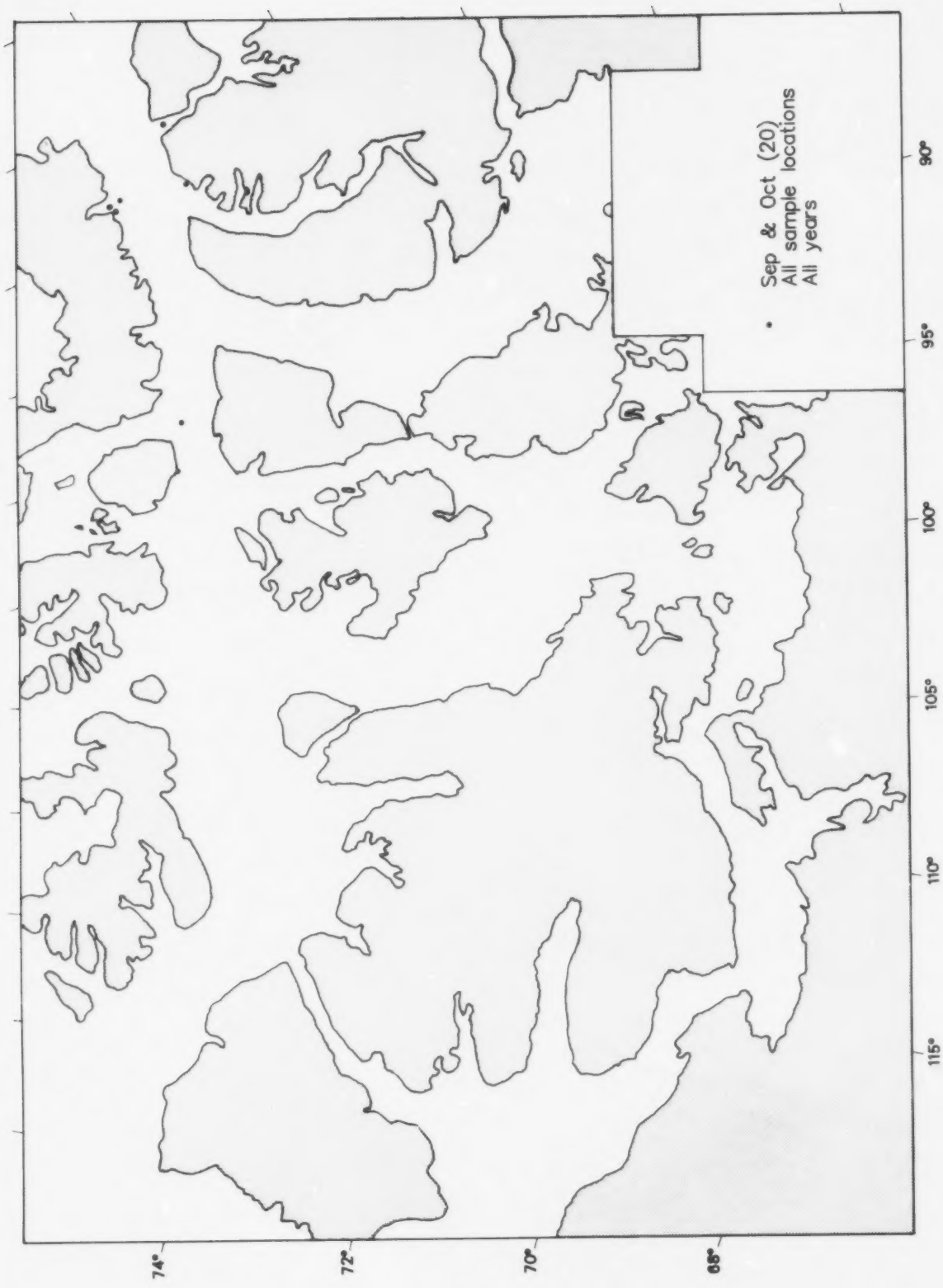
10.1 Geographic occurrence of chemical oceanographic data on a cumulative bi-monthly basis.

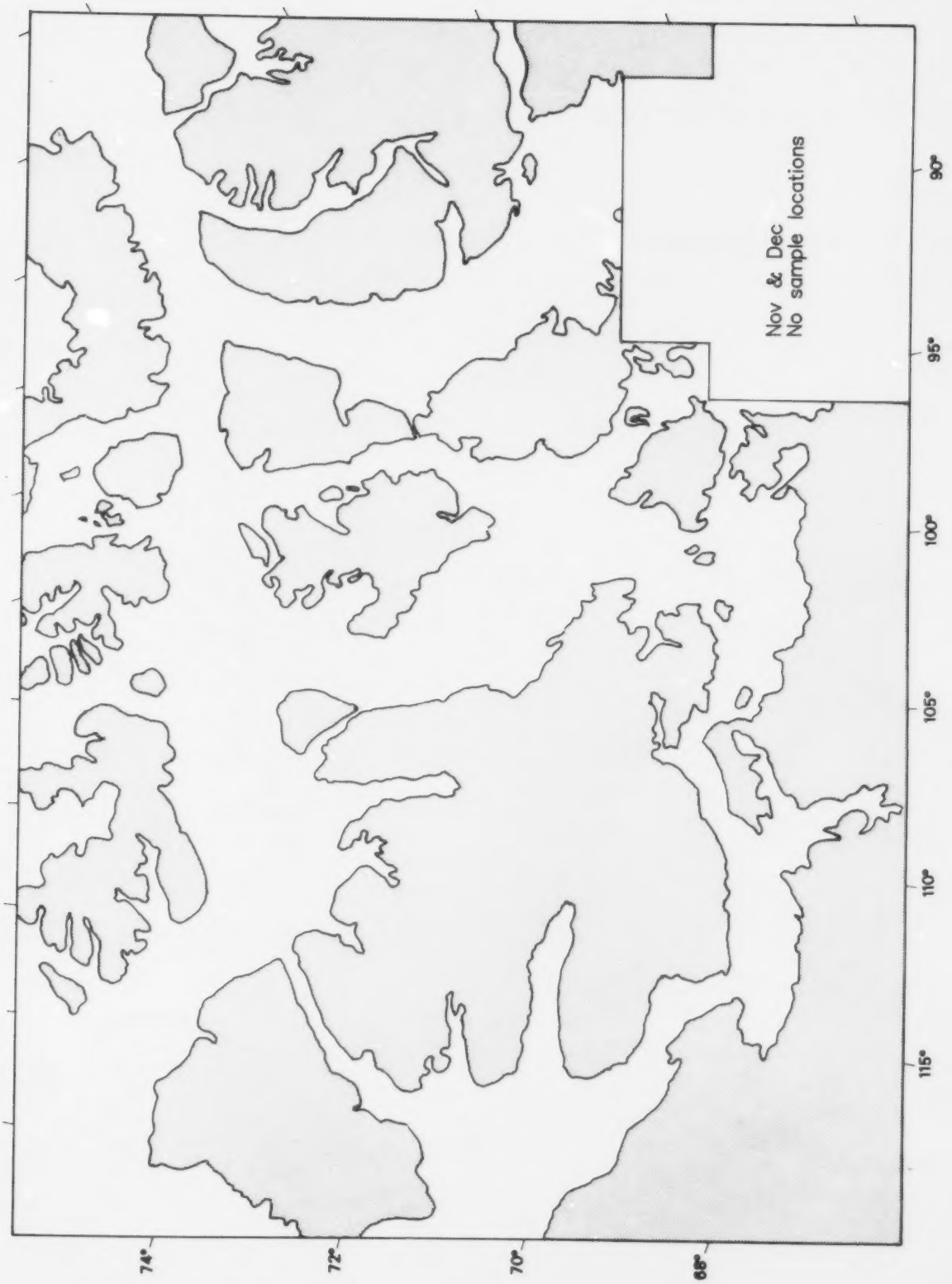

Jan & Feb
No sample locations
90°
95°
100°
105°
110°
115°
74°
72°
70°
68°


Mar & Apr (49)
All sample locations
All years
90°
95°
100°
105°
110°
115°
74°
72°
70°
68°

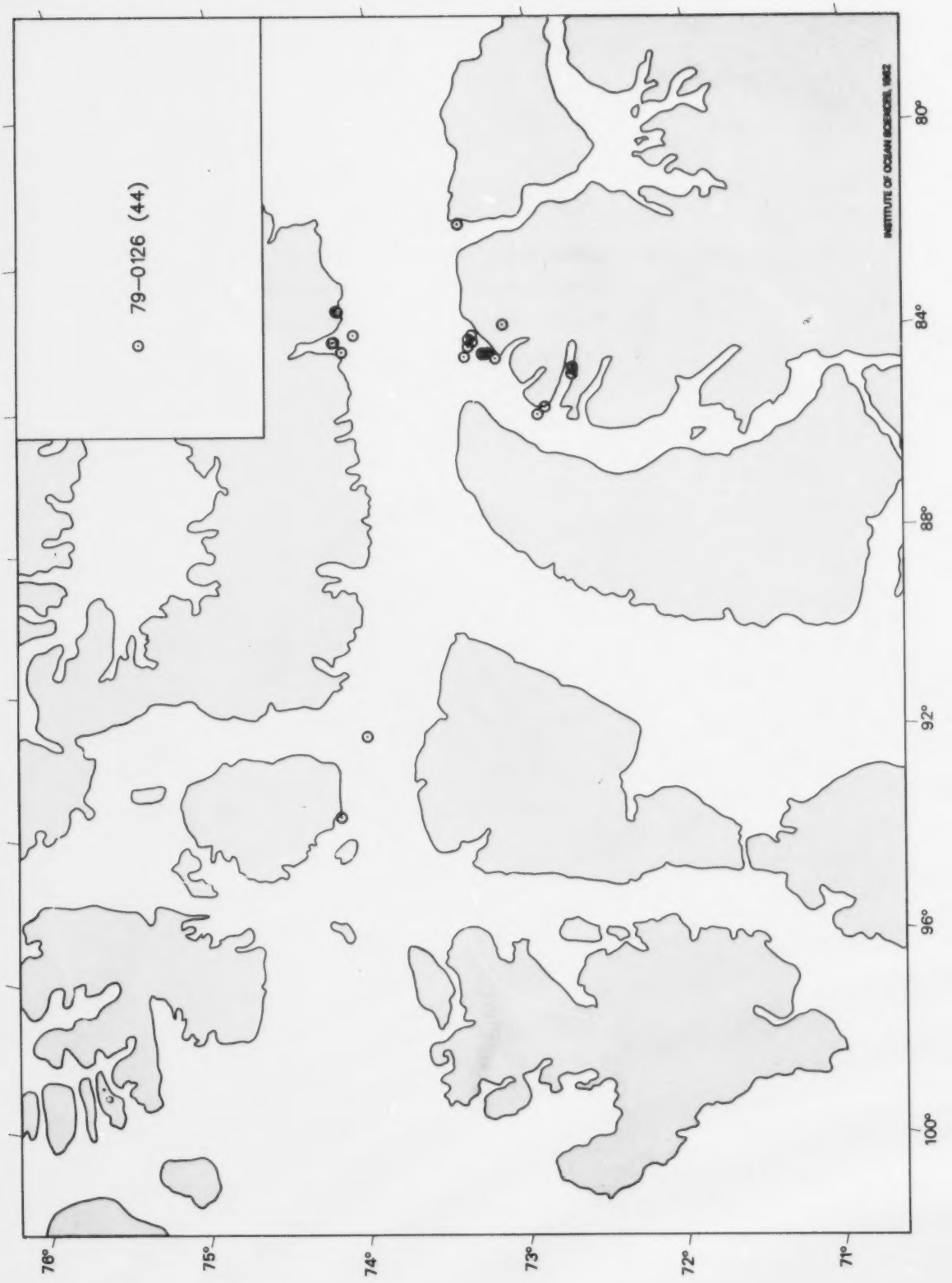

74°
72°
70°
68°
115°
110°
105°
100°
95°
90°
May & June (43)
All sample locations
All years

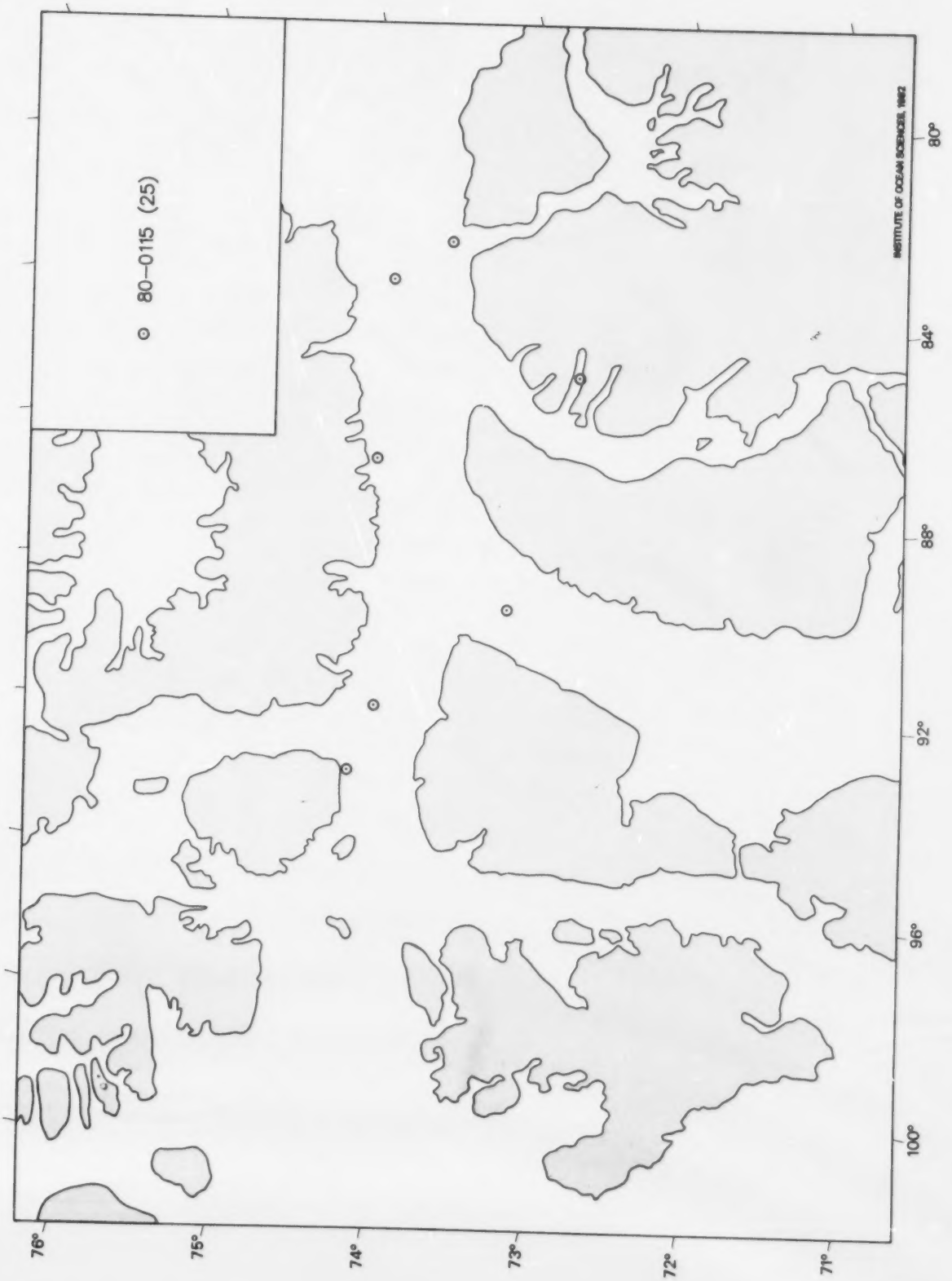

Jul & Aug (59)
All sample locations
All years
74°
72°
70°
68°
115°
110°
105°
100°
95°
90°


Sep & Oct (20)
All sample locations
All years
90°
95°
100°
105°
110°
115°
74°
72°
70°
68°


Nov & Dec
No sample locations
90°
95°
100°
105°
110°
115°
74°
72°
70°
68°

10.2 Geographic occurrence of chemical oceanographic data on a yearly basis. (Number of stations for each data set provided in brackets.)


79–0126 (44)
INSTITUTE OF OCEAN SCIENCES, 1982
78°
75°
74°
73°
72°
71°
80°
84°
88°
92°
96°
100°


80–0115 (25)
INSTITUTE OF OCEAN SCIENCES, 1982
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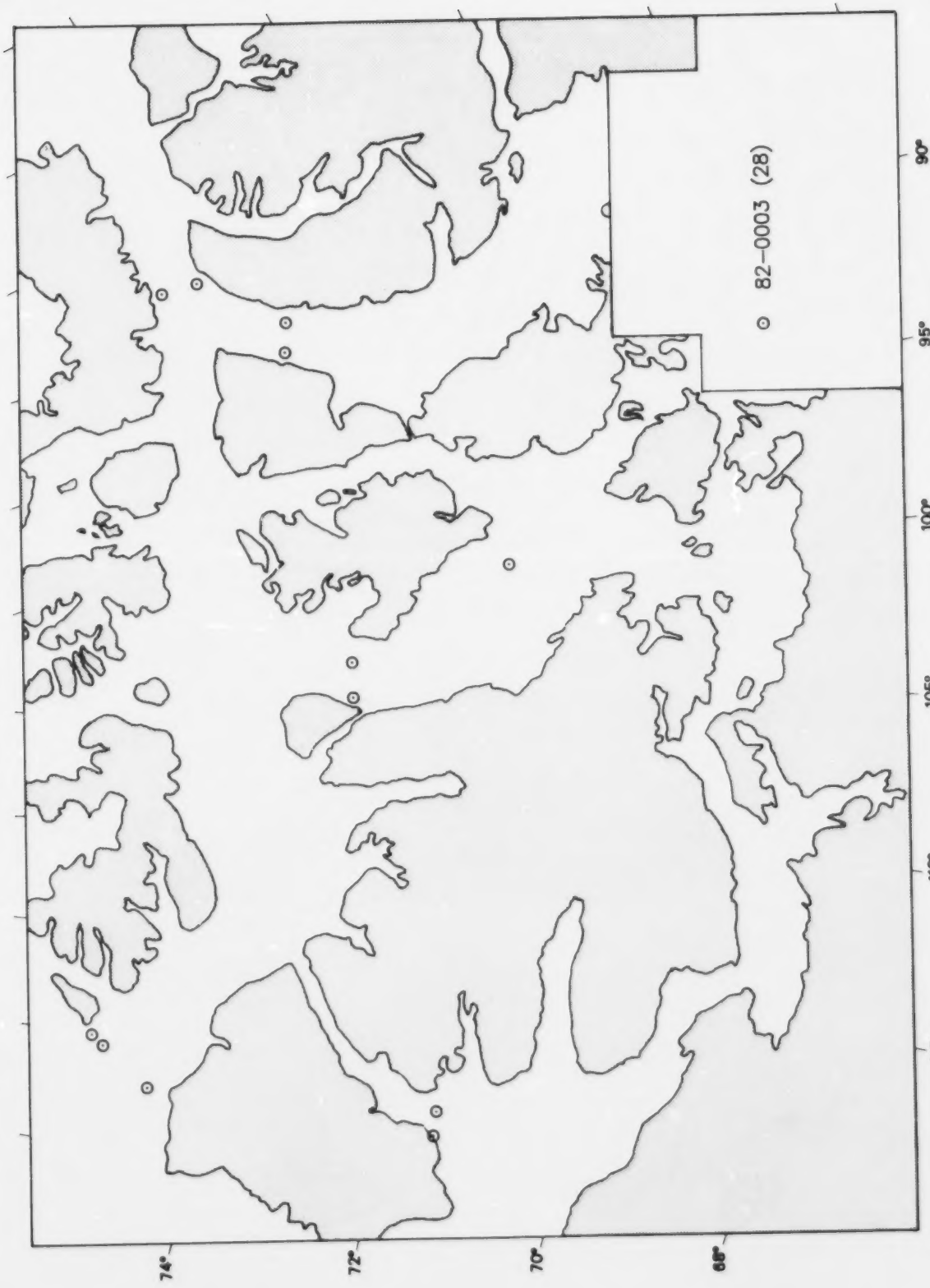
75°
74°
73°
72°
71°
100°
96°
92°
88°
84°
80°


82–0003 (28)
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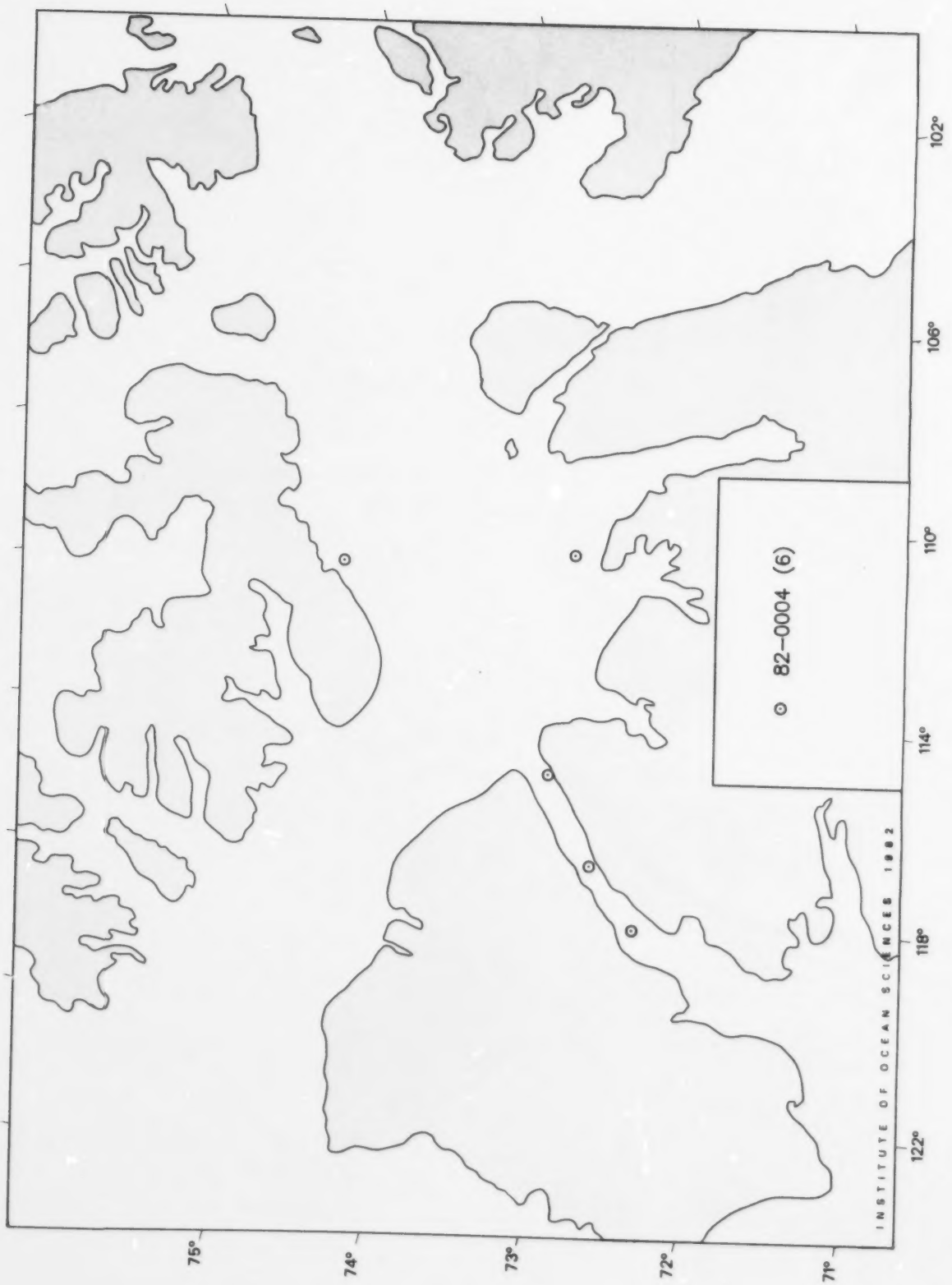
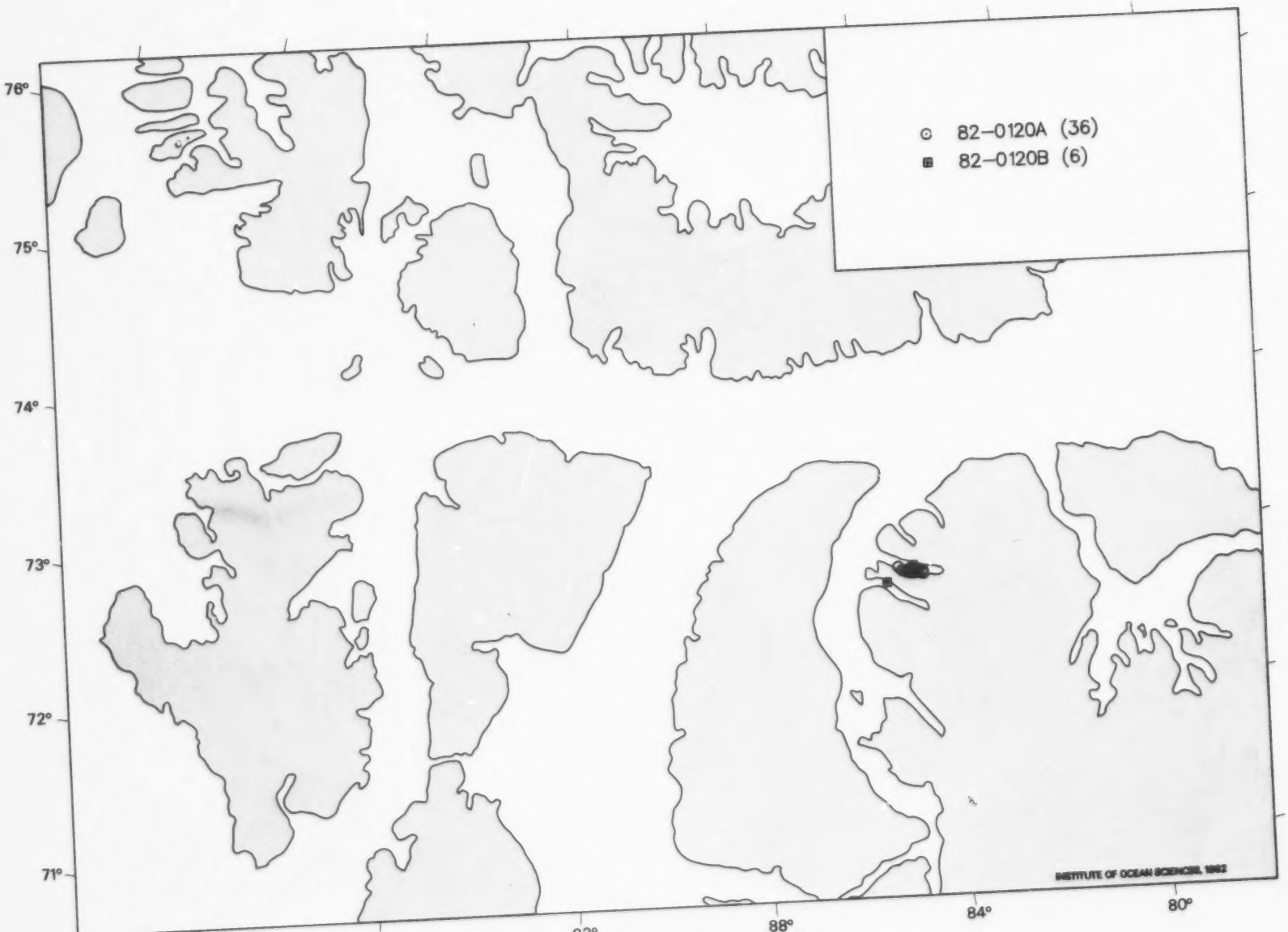
100°
105°
110°
115°
74°
72°
70°
68°


82-0004 (6)
INSTITUTE OF OCEAN SCIENCES 1982
102°
106°
110°
114°
118°
122°
75°
74°
73°
72°
71°


82–0120A (36)
82–0120B (6)
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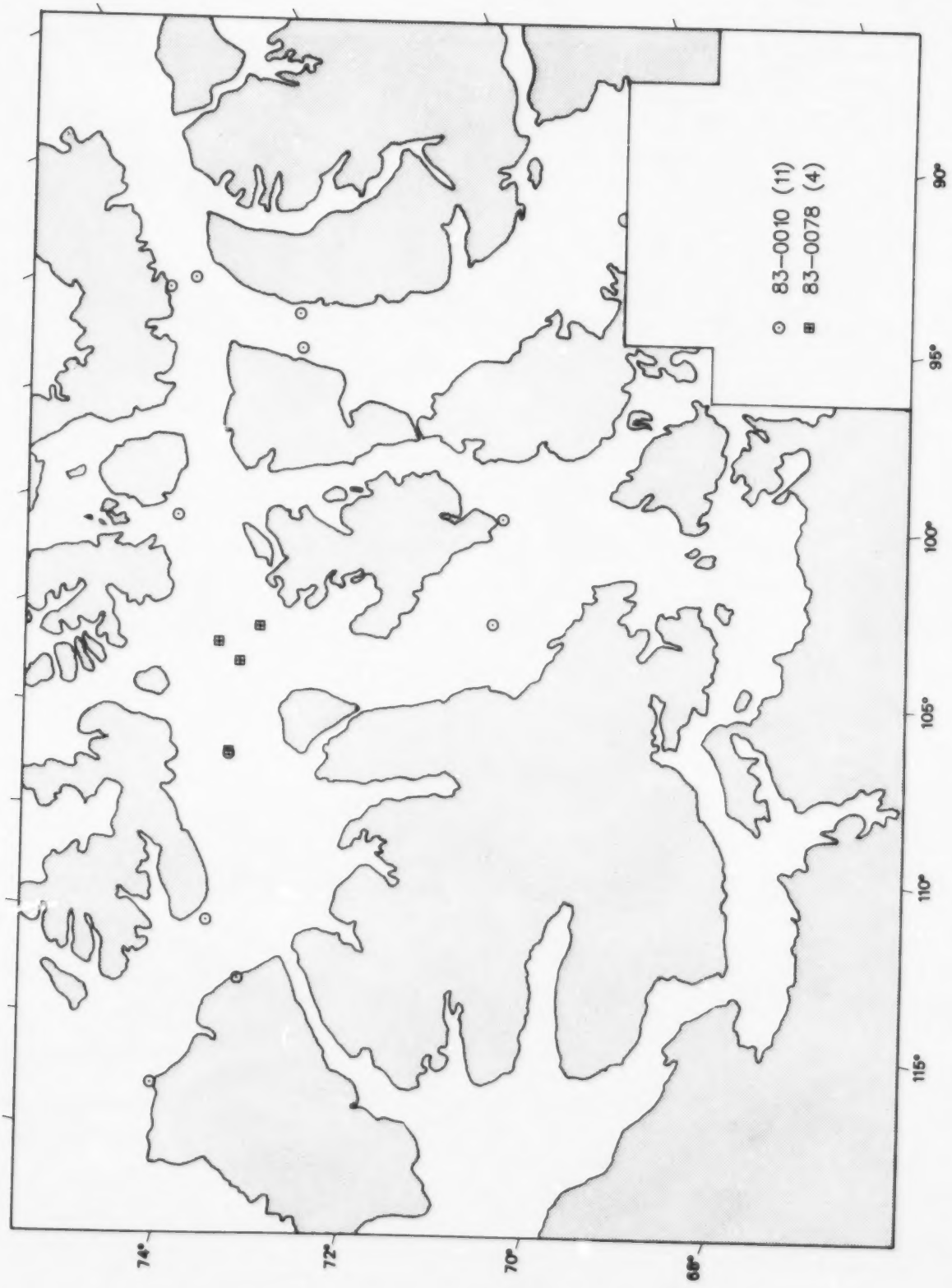
75°
74°
73°
72°
71°
88°
84°
80°
INSTITUTE OF OCEAN SCIENCES, 1982


83-0010 (11)
83-0078 (4)
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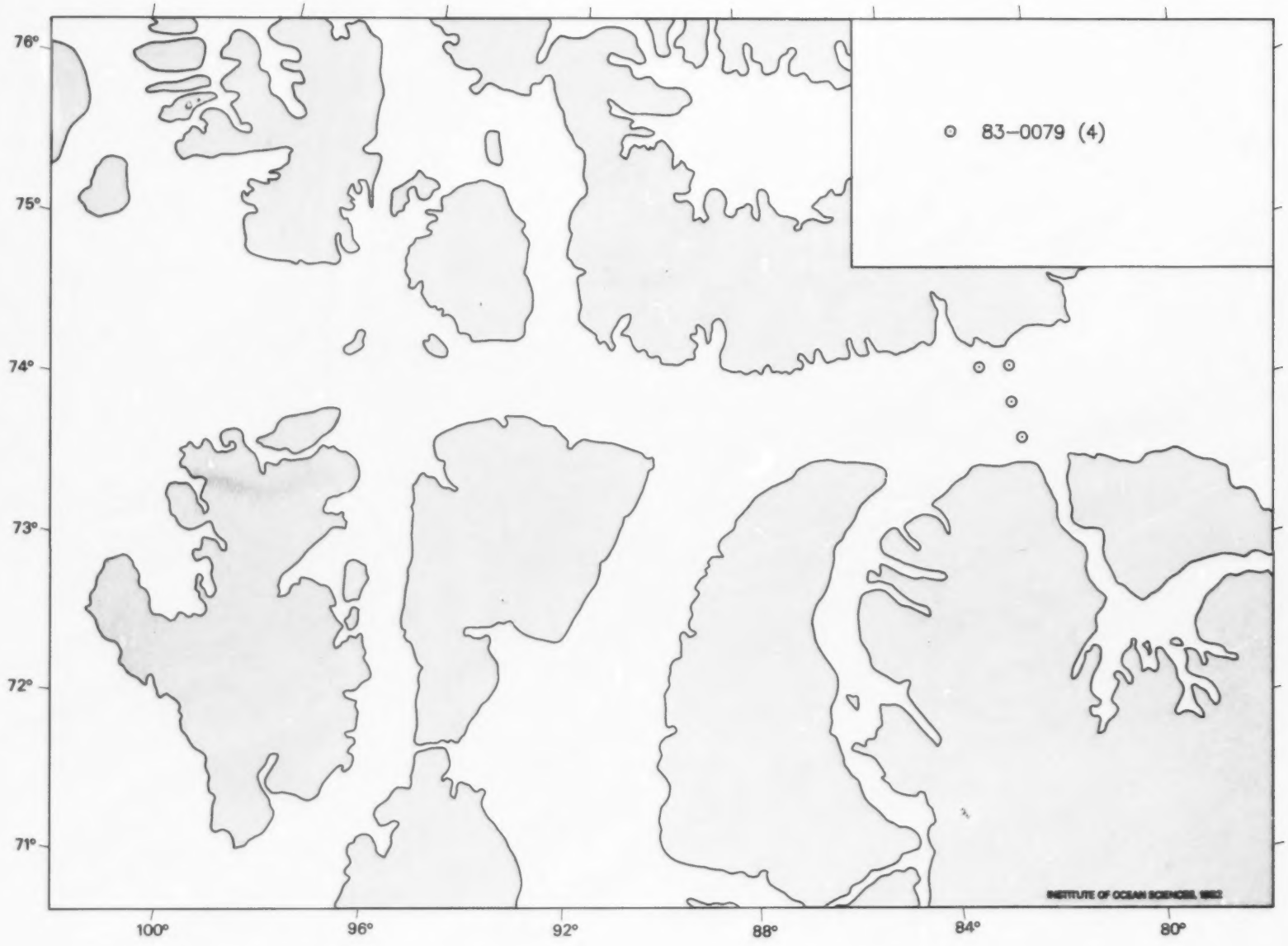
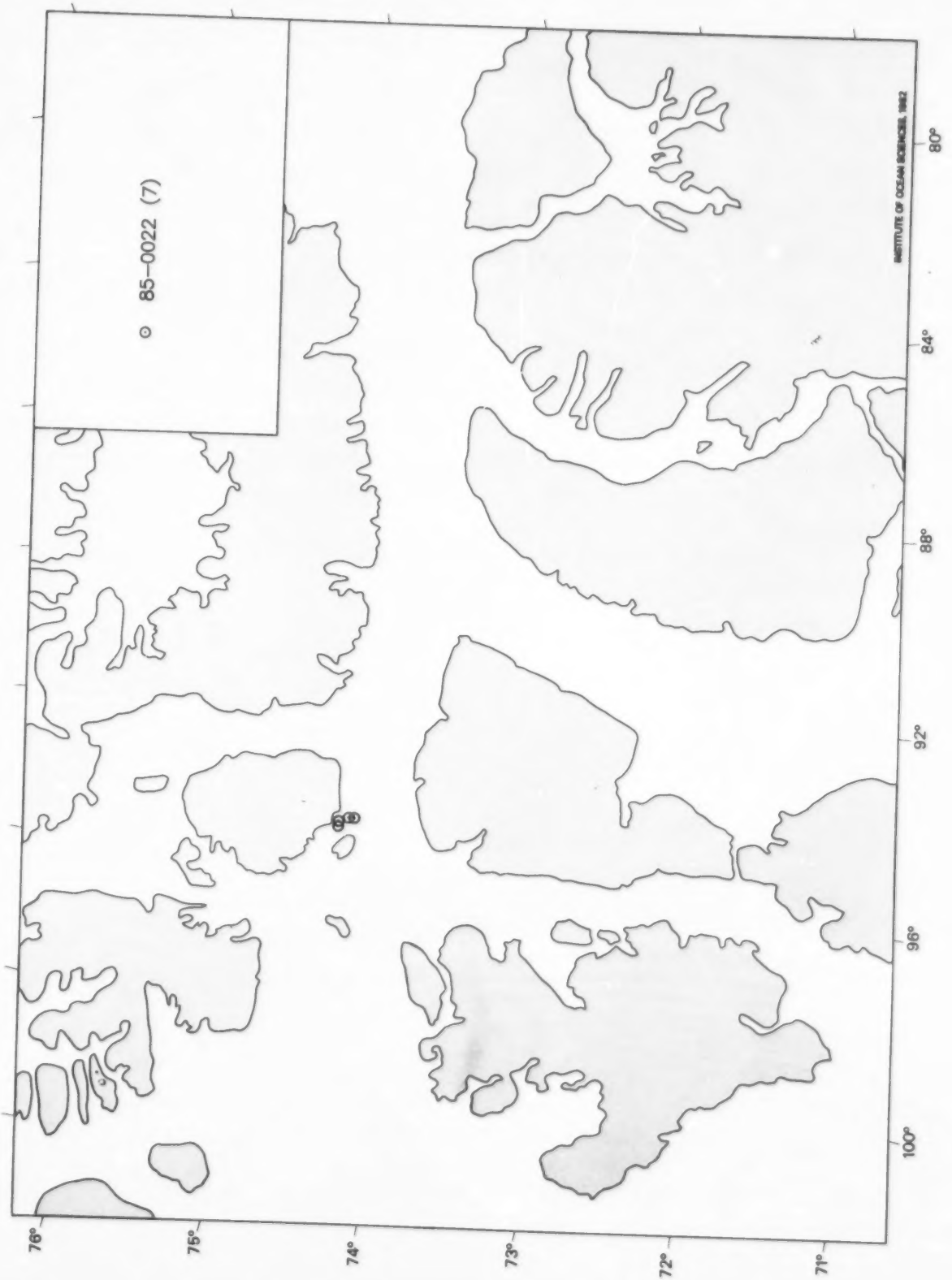
100°
105°
110°
115°
74°
72°
70°
68°


83–0079 (4)
76°
75°
74°
73°
72°
71°
100°
96°
92°
88°
84°
80°
INSTITUTE OF OCEAN SCIENCES, 1983


85-0022 (7)
INSTITUTE OF OCEAN SCIENCES, 1982
80°
84°
88°
92°
96°
100°
76°
75°
74°
73°
72°
71°

11. INDICES

11.1 Geographic Index of Data Set Occurrence

11.2 Index of References by Data Set Number

11.1 Geographic Index of Data Set Occurrence

BARROW STRAIT	EASTERN VISCOUNT MELVILLE SOUND	LANCASTER SOUND	McCLURE STRAIT	PRINCE REGENT INLET	PRINCE OF WALES STRAIT	STRATHCONA SOUND	VISCOUNT MELVILLE SOUND
82-0003	83-0078	79-0126	82-0004	83-0010	82-0004	82-0120A	82-0003
83-0010		80-0115	83-0010			82-0120B	82-0004
83-0078		83-0010					83-0010
85-0022		83-0079					85-0022

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(Secondary references are indented.)

79-0126 Irwin, B., P. Dickie, P. Lindley and T. Platt, 1984. Phytoplankton productivity in Lancaster Sound and approaches during the summer of 1979. Can. Data Rept. Fish. Aquat. Sci. No. 423, 103 pp.

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82-0004 Buckingham, W.R., R.A. Lake and H. Melling, 1985. Temperature and salinity measurements in the Northwest Passage, Volume 1, March-April, 1982. Can. Data Rep. Hydrogr. Ocean Sci. No. 39, 371 pp.

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Woods, S. and B.D. Smiley. 1987. Volume 9. Beaufort Sea: Biological Oceanography – Bacteria, Plankton and Epontic Community, 1914 through 1985. Vol. 9, 412p.

Norton, P., B.D. Smiley and L. de March. 1987. Volume 10. Beaufort Sea: Biological Oceanography – Whales, 1848-1983. Vol. 10, 407p.

Wainwright, P.F., B.D. Smiley and A. Blyth. 1987. Volume 11. Beaufort Sea: Biological Oceanography–Marine Zoobenthos, 1914 to 1986. Vol. 11, 367p.

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